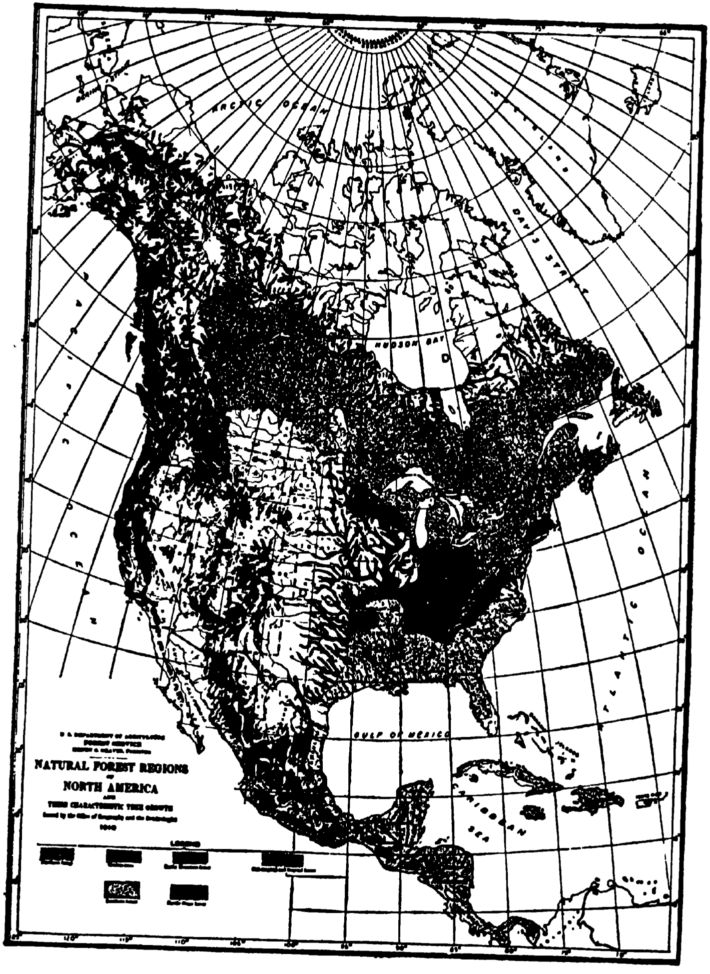
PULPWOOD AND WOOD PULP
IN NORTH AMERICA

McGraw-Hill Book Co. Inc.
PUBLISHERS OF BOOKS FOR

Electrical World ▿ Engineering News-Record
Power ▿ Engineering and Mining Journal-Press
Chemical and Metallurgical Engineering
Electric Railway Journal ▿ Coal Age
American Machinist ▿ Ingenieria Internacional
Electrical Merchandising ▿ Bus Transportation
Journal of Electricity and Western Industry
Industrial Engineer



Natural Forest Regions of North America (*Frontispiece*)

PULPWOOD
AND WOOD PULP
IN NORTH AMERICA

BY

ROYAL S. KELLOGG

Author of "Lumber and Its Uses", "The Cost of Growing Timber",
"The Timber Supply of the United States", etc.

DIRECTOR ... TRIES. BENGAL.
LIBRARY
21 JUL. 1924

FIRST EDITION

McGRAW-HILL BOOK COMPANY, INC.
NEW YORK: 370 SEVENTH AVENUE
LONDON: 6 & 8 BOUVERIE ST, E. C. 4
1923

676.70
K 291

Copyright, 1923, by the
McGraw-Hill Book Company, Inc.

PRINTED IN THE UNITED STATES OF AMERICA

2423

TO THOSE WHO HELPED

The writing of this book was made a pleasure through the generous assistance of many friends and to them grateful acknowledgment is rendered.

Many of the illustrations are from photographs taken by the author. Others were kindly supplied by the United States Forest Service, the Dominion Water Power Branch, the Abitibi Power and Paper Company, the Alaska Pulp and Paper Company, the American Voith Contact Company, the Belgo-Canadian Paper Company, the Bogalusa Paper Company, the Fairchild Aerial Surveys, Ltd., the International Paper Company, the Laurentide Company, the Spanish River Paper Mills, the Strathmore Paper Company, the Washington Pulp and Paper Corporation, the Fabricas de Papel de San Rafael Y Anexas, S. A., the Waterous Engine Works, Ltd., the National Board of Fire Underwriters and Messrs. C. L. Tolles and Albert T. Reid.

Much of the statistical data was derived from official reports of the Dominion Bureau of Statistics and the Conservation Commission of Canada, and from reports of the Bureau of the Census and the Forest Service in the United States. Well-known books and other publications in the pulp and paper industry were also a most useful source of reference.

The names of the individuals who gave help in various forms would make a long list. Much and varied assistance was received from the office associates of the author. Messrs. W. G. MacNaughton, R. O. Sweezey, R. G. Lewis, John D. Rue, R. D. Craig, A. H. O. Rolle, G. C. Piche, J. N. Stephenson, Ellwood Wilson, R. B. Wolf and F. T. Harris furnished especially valuable material and suggestions. To C. W. Boyce great credit is due for checking and supplementing the statistical compilations and equal credit is due to C. W. Halligan who transformed the rough sketches of the author into the numerous graphs which it is hoped to some extent make clear facts and tendencies that otherwise would remain obscured in tiresome tables of figures.

If the final result shall be to promote a better understanding of the part played by the forest in supplying an indispensable factor in modern life the author will deem his purpose accomplished, whatever fault may be found with his opinions or their method of presentation.

R. S. K.

NEW YORK, N. Y.,
August, 1923.

CONTENTS

To Those Who Helped vii

PART I.—WOOD PULP

CHAPTER I

Page

Recording Materials 3

The First Paper—The Application of Power—Wood the Great Raw Material—Magnitude of the American Industry—A Paper Age.

CHAPTER II

Processes 16

Mechanical Process—Sulphite Process—Soda Process—Sulphate Process.

CHAPTER III

Consumption of Wood Pulp in North America 43

United States—Canada—Paper Production.

PART II.—PULPWOODS

CHAPTER IV

Logging 53

CHAPTER V

The Unit of Measurement 58

Log Scales — What Is a Cord? — Conversion Factors — Better Methods.

CHAPTER VI

Pulpwood Grades 65

CHAPTER VII

Pulpwood Used in North America 67

Quantities—Comparative Consumption—Processes—Regions—Species—Costs.

CHAPTER VIII

Properties of American Pulpwoods 97

PART III.—TIMBER SUPPLY

CHAPTER IX

Forest Regions 137

The Northern Forest—The Southern Forest—The Central Hardwood Forest—The Rocky Mountain Forest—The Pacific Forest.

CHAPTER X

PAGE
WHAT WE HAVE 147
In the United States—In Canada—The Total for North America.

CHAPTER XI

FOREST OWNERSHIP 167
In the United States—In Canada.

PART IV.—TIMBER PRODUCTION

CHAPTER XII

THE NEED FOR FORESTRY 173

CHAPTER XIII

THE CHANCE FOR FORESTRY 177
Where Forestry Should Begin.

CHAPTER XIV

THE METHODS OF FORESTRY 184
Working Plans.

CHAPTER XV

THE HAZARDS OF FORESTRY 191

CHAPTER XVI

THE COST OF FORESTRY 194
Land Values—Taxes—Interest Rates—Some Examples.

CHAPTER XVII

THE RESPONSIBILITY FOR FORESTRY 202
National Economy—Who Is Concerned—Essentials in the Solution of the Problem.

CHAPTER XVIII

WHAT SHOULD BE DONE 207
In the United States—In Canada.

PART V.—A PERMANENT INDUSTRY (?)

CHAPTER XIX

TO GROW MORE WOOD 219

APPENDIX 223
Statistical Data—Sample Working Plan for Adirondack Softwoods—Technical Outline re Forest Surveys and Working Plans—Advertisement of Timber Sale in Ontario—A British Columbia Timber Sale Contract—A National Forest Timber Sale Agreement—Cost Tables—Pulping Properties of Some Woods.

INDEX 269

ILLUSTRATIONS

FIGURE PAGE
Forest regions of North America . . . *Frontispiece*
1. Paper and pulp mills in North America, 1922 . . . 6
2. A self-contained modern news print mill of 500 tons daily capacity . 8
3. The pulp and paper industry in the United States, 1879–1919. . . 10
4. A grinder-room in a pulp mill showing the 3-pocket style of grinder . 11
5. Per capita consumption of all paper in various countries, 1920 . . . 12
6. Per capita consumption of paper in the United States, 1909–1920 . 14
7. Magazine grinders in a modern pulp mill . . . 17
8. Rated capacity of the pulp industry—United States and Canada . 18
9. A "caterpillar" magazine grinder . . . 20
10. Water power in Canada . . . 22
11. News print production, United States and Canada, 1913–1923 . . . 24
12. News print production, United States and Canada, 1904–1922 . . . 26
13. Mechanical pulp. Spruce fibres greatly magnified . . . 28
14. Production of wood pulp in the United States, 1899–1922 . . . 30
15. The only pulp mill in Alaska . . . 31
16. Wood pulp in the United States—domestic and imported . . 32
17. The most northern paper mill in America . . . 35
18. Production of wood pulp in Canada, 1908–1922 . . . 36
19. The only complete modern pulp and paper mill in Mexico . . . 38
20. Wood pulp in Canada—produced and exported . . . 40
21. Laying out the site for a great paper mill in Canada . . . 42
22. Imports of wood pulp into the United States, 1905–1922 . . . 44
23. Imports of sulphite pulp into the United States, 1917–1922 . . . 46
24. Imports of sulphate pulp into the United States, 1917–1922 . . . 48
25. Paper production in the United States and Canada, 1922 . . . 50
26. Digesters in a sulphite pulp mill . . . 54
27. Acid-making towers at a sulphite pulp mill . . . 56
28. The beater room in a paper mill . . . 59
29. Hydraulic pulp presses . . . 61
30. A modern high speed paper machine . . . 63
31. Pulpwood used—United States and Canada, 1908–1922 . . . 68
32. Pulpwood used in the United States, 1880–1922 . . . 70
33. Sulphate pulp. Spruce fibres greatly magnified . . . 71
34. Pulpwood used in the United States—domestic and imported . . . 72
35. Pulpwood in Canada—produced and exported . . . 74
36. A kraft mill in Louisiana . . . 75
37. Pulpwood used in the United States by processes, 1908–1922 . . . 76
38. Pulpwood used in Canada by processes, 1908–1922 . . . 78
39. Soda pulp. Red maple fibres greatly magnified . . . 80
40. Loading a 1200-lb. roll of finished paper . . . 81

FIGURE PAGE
41. Pulpwood used in the United States, by regions, 1904–1922 84
42. Paper mills which make their own groundwood and sulphite pulp . 86
43. Pulpwood used in Canada, by provinces, 1910–1922 88
44. Monorail carrier used to transport rolls of paper 89
45. Principal kinds of pulpwood used in the United States, 1899–1922 . 90
46. Pulpwood consumption in Canada by species, 1908–1922 92
47. Pulpwood in Canada, 1910–1921 (by Provinces) 94
48. The old and the new in timber transportation 98
49. A log slide in the woods 101
50. A tractor hauling spruce pulpwood 103
51. Typical construction of a timber dam 105
52. The most important man in the logging camp—the cook 107
53. Douglas fir logs in the state of Washington 109
54. A raft of spruce logs in Southeastern Alaska 111
55. Breaking a log jam 113
56. Cottonwood logs at a paper mill 115
57. Some extra-fine spruce at a British Columbia paper mill 117
58. A paper mill in the Berkshires 119
59. Disc barkers in a pulp mill 121
60. Drum barkers at a large paper mill 122
61. Pulpwood in the log pond on the way to the slashers 124
62. Slasher saws which cut pulpwood 127
63. A pulpwood stacker 129
64. Spraying a pile of pulpwood to reduce the fire hazard 132
65. Fire in the forest 134
66. Forest and woodland in the United States 138
67. National Forests in the United States 142
68. The tundra country in Alaska 144
69. Typical forest in Central Oregon 147
70. Typical upland country in Labrador 151
71. Black spruce at timber line near the Arctic Circle 156
72. A typical interior Alaskan scene 161
73. A bit of Northern British Columbia near the coast 163
74. Pulpwood cutting in a California National Forest 165
75. Forest fire in Oregon as seen from an airplane 175
76. Forest types in pulpwood territory photographed from an airplane . 178
77. Natural growth of birch and poplar in Quebec 182
78. Flooding of land by beaver dams 186
79. Pulpwood decay following budworm attack 189
80. Making it easy for the camper to be careful with fire 193
81. Looks like no forest policy means no timber 196
82. Natural reproduction of spruce and balsam fir in New Brunswick . 200
83. Natural pine reproduction in Louisiana 204
84. The forest after fire has done its work 208
85. Part of a forest nursery of a paper company 212
86. Airplane view of a modern pulp and paper mill 216
87. Fire—the greatest enemy of the forest 220

PART I

WOOD PULP

DIRECTOR ... TRIES. LIBRARY. 21 JUL. 1924 BENGAL.

PULPWOOD AND WOOD PULP IN NORTH AMERICA

CHAPTER I

RECORDING MATERIALS

Civilization became possible when man developed the ability to record his thoughts, observations, inventions and discoveries in some permanent form and pass them on to the man who came after him. And were every printed or other record obliterated today, civilization would vanish like a puff of smoke.

It has been aptly pointed out that this power of linking past to present, which gives each generation the opportunity to start its climb from the shoulders of the preceding generation, is one of the fundamental distinctions between man and the so-called lower animals, some of whose other attributes are superior to those of man. Starting perhaps with charcoal or ochre sketches on cave walls or rude chiselings in stone slabs, man has steadily improved his processes and materials of expression until his output of written, printed, painted, carved and recorded matter has reached astounding proportions.

Throughout the ages, there has been constant search for material upon which records might be preserved. Most important of all in its influence upon human development was the discovery of recording material which, in addition to the preservation of the message upon its surface, could be easily transported from place to place. Only through such a medium did the diffusion of knowledge become possible.

It is a far cry from the charred stick and the cavern wall to the machine which makes a thousand feet of paper a minute in a sheet a dozen feet wide and to the printing press which delivers newspapers at an even more rapid rate. In between there lies an endless series of gropings, experiments, discoveries and inventions. Almost every imaginable substance in the mineral, animal and vegetable kingdoms has been tried or suggested for the preservation of human records. The list extends from clay, stone and wooden tablets, metal plates and animal skins to literally hundreds of vegetable forms. Even today newspaper items are common to the effect that some great, new paper-making material has just been discovered, when the chances are that it was long ago tried and found wanting.

The First Paper.—Papyrus, a luxuriant water sedge with a stem roughly triangular in cross-section and with a fibrous pith, from which our term "paper" is derived, was the civilized world's most important recording material for more than 5,000 years, although true paper was never made from it. The sheets made by laying thin slices of papyrus pith in criss-cross fashion and applying heavy pressure served their purpose remarkably well, but it was not until the invention of the process of maceration by Ts 'a i-Lun in China about 130 A.D. that the first real paper was made. This was from the inner bark of a tree, but it was nearly 2,000 years later when scientific knowledge made it possible to turn to the forest for a wealth of paper-making material not hitherto suspected.

Following papyrus, rag paper appeared in China in the third century A.D., later spreading westward to Arabia and then to Italy during the second Crusade. Paper was also introduced into Spain by the Moors.

Cotton and linen rags since their first use have been the most important material for high-grade papers, and doubtless will so continue in the future. The long and strong fibers of these materials, together with their adaptability to paper-making processes, have made them indispensable where strength and durability are required.

But the continually growing demand for paper kept up a keen search for other fibers that might be used to replace or supplement rags, as evidenced by such early United States patents as those for the making of paper from beach grass, corn husks, stalks and cobs; seagrass and seaweed; reeds, sorghum and cotton stalks—none of which has attained commercial success.

The first paper mill in the United States was started in the then outskirts of Philadelphia in 1690 and used linen rags, but the industry, with mills developing in New England, New York and other parts of the Colonies, was short of raw material for 100 years, and paper was generally scarce and insufficient for the needs of the people. Paper mills were granted governmental favors and paper-makers were exempted from military service during the Revolution.

The Application of Power.—The substitution of power-driven equipment like the beating engine and the cylinder and fourdrinier paper machines for the old hand methods, early in the nineteenth century, followed by the rotary rag-boiler and then by the several wood-pulp processes made possible a tremendous increase in output in all paper-making countries, with the greatest development in North America. In recent years there have been few basic changes, but much improvement of equipment and speeding up of operations.

The Census of 1810 reported 200 paper mills in the United States with an output estimated at 500 tons for newspapers, 630 tons of book papers, 650 tons of writing papers and an annual total of 3,000 tons. In 1860, the paper industry in the United States had grown to 555 mills with a yearly output of 127,000 tons of which 66,000 tons was printing paper. At this date the average annual output per mill was about 230 tons compared with 15 tons 50 years earlier, clearly showing the effect of the introduction of machinery and improved processes. But contrast these

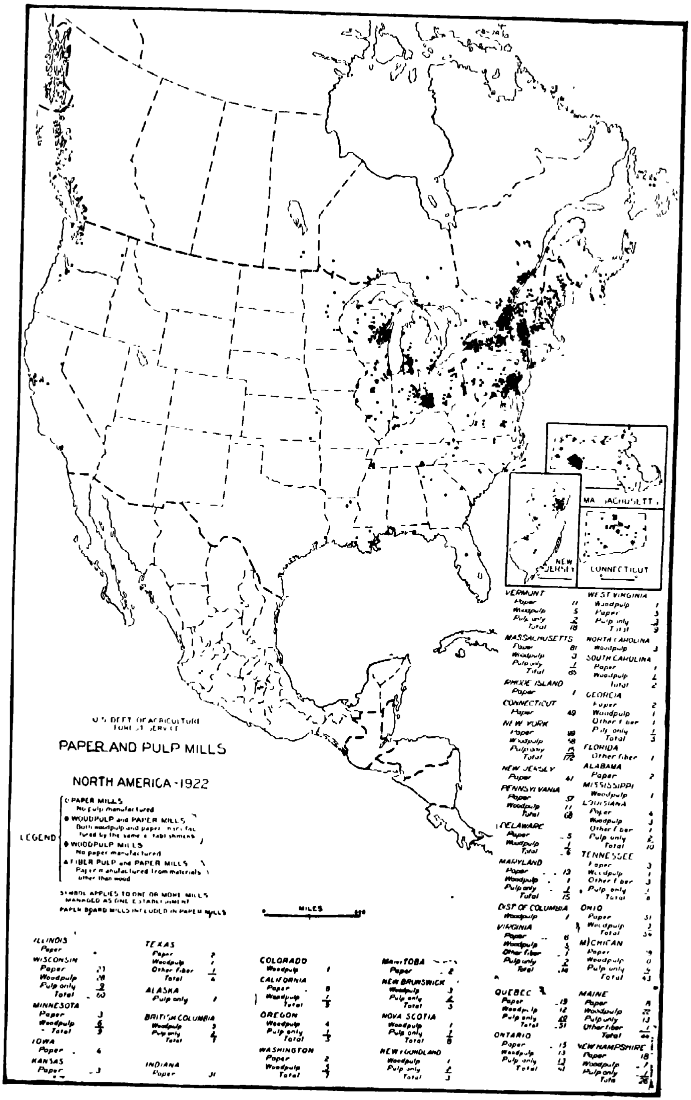


FIG. 1.—Paper and pulp mills in North America, 1922.

figures with an output of 7,335,000 tons in 1920—an increase of more than 2,400 times while population was increasing 15 times during the same 110 years, to say nothing of an excess of 600,000 tons of imports of paper over exports in 1920 in addition to the record-breaking production.

Where 200 paper mills produced a total of but 3,000 tons of paper per year a little more than 100 years ago there are now single mills in North America which steadily turn out more than 100,000 tons of paper every 12 months. This tremendous expansion is due almost entirely to the use of wood as a raw material and the application of power thereto.

The effect of the opportunity to use a new and abundant raw material and the results of the application of mechanical power to paper-making are early shown when the record of the development of the industry in the United States is studied for the 50 years following the first practical use of wood for paper pulp.

In 1869, there were 677 paper-making establishments in the United States—large and small—and they were mostly small as indicated by the fact that the average mill had 27 employees, required 80 horsepower and represented an invested capital of $51,000.

Each succeeding decennial census reported steady increases in these and other items except for the total number of establishments, in which there has been a slight falling off in the past 10 years as economic production has favored the development of larger units. In 1919, the census noted 729 paper-making establishments in the United States, in which the average operation had 156 wage earners, employed 2,540 hp. and represented an invested capital of $1,240,000.

To put the matter more clearly, in the 50 years following 1869 the average paper mill in the United States increased 6 times in the number of employees, 32 times in the amount of power used and 24 times in invested capital.

Even more striking is the magnitude of the mills which

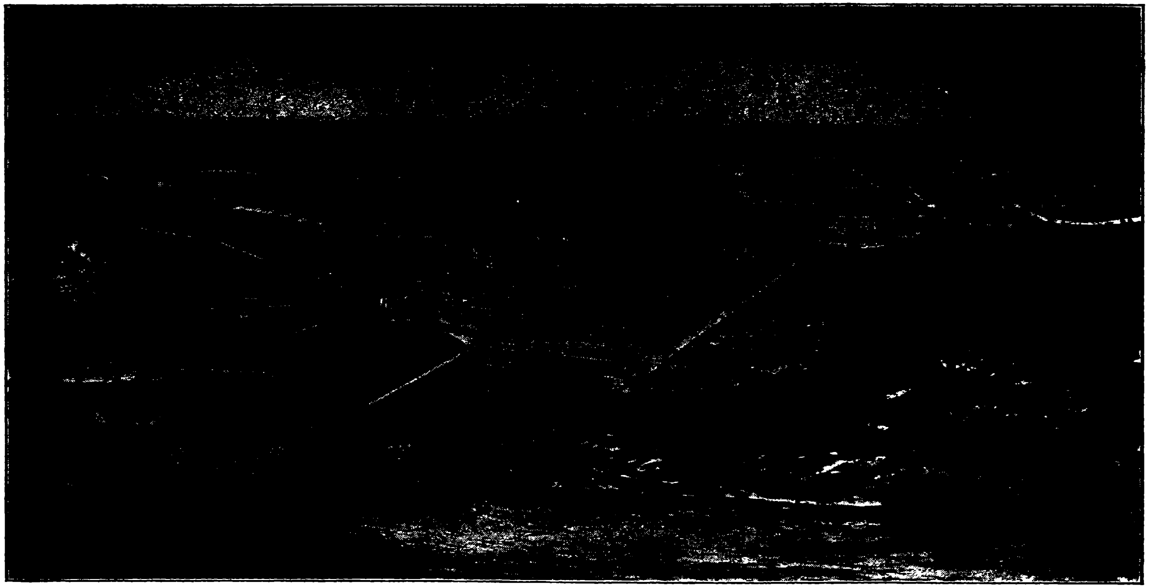


Fig. 2.—A self-contained modern news print mill of 500 tons daily capacity. The block pile holds 100,000 cords of pulpwood.

make both pulp and paper when separated from the conversion mills which make paper from purchased pulp. The 1919 census found 171 of these self-contained establishments in the United States for which the average was 360 employees, 6,700 hp. and $2,900,000 invested capital each.

Wood the Great Raw Material.—The early statistics are very defective, but it is conservatively estimated that about 2,000 cords of wood were used for paper-making in the United States in 1870 and more than 40,000 cords in 1880. The wood-pulp industry really got into its stride in 1890 with some 580,000 cords which with occasional haltings grew to a maximum of more than 6,000,000 cords in 1920,—just 50 years after there was the first census basis for an estimate of wood as a raw material for paper-making in the United States. At least 100,000,000 cords of wood have gone into paper in the United States since wood pulp was first made.

There are no reliable figures for Canadian pulpwood consumption prior to 1908 when it was 483,000 cords, but since that date there has been a steady increase up to 2,777,000 cords in 1920 and the end is not yet. Not less than 30,000,000 cords of wood have been used in Canada for paper-making.

Taking the United States and Canadian industries together with one common source of raw material—the forests of North America—we find that in round numbers the requirements for pulpwood amounted to 3,830,000 cords in 1908, to 5,000,000 cords in 1911, to 6,993,000 cords in 1916 and to 8,890,000 cords in 1920.

Of this total consumption of 130,000,000 cords of pulpwood, spruce and balsam have supplied 95 per cent in Canada and about 65 per cent in the United States. Other of the more important contributing species in the United States have been hemlock and poplar, together, in recent years, with Southern pine, the use of which for sulphate pulp will evidently increase for some time.

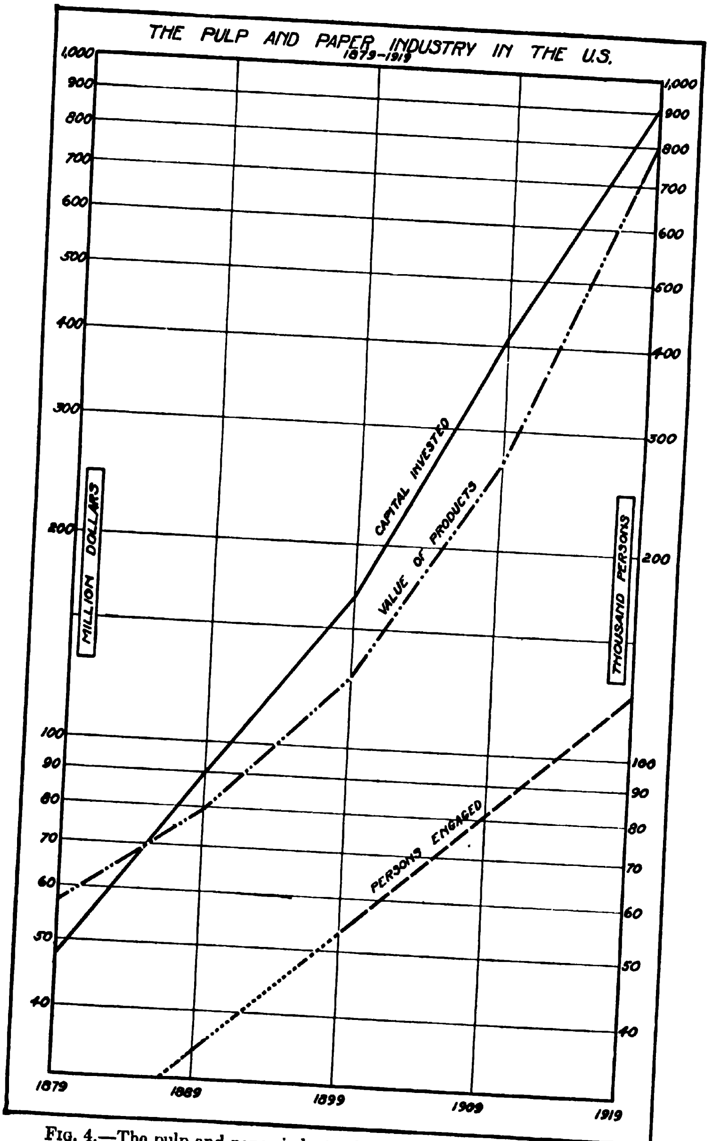


FIG. 4.—The pulp and paper industry in the United States, 1879–1919.

Magnitude of the American Industry.—In 1919, the last census year, there were 729 pulp and paper establishments in the United States with a capital exceeding $900,000,000 in which nearly 125,000 persons were engaged who received more than $135,000,000 in salaries and wages and with products valued at $788,000,000. The power employed in the industry was rated in excess of 1,850,000 hp. of which nearly half was waterpower and more than a ton and a quarter of coal was used for every ton of paper produced.

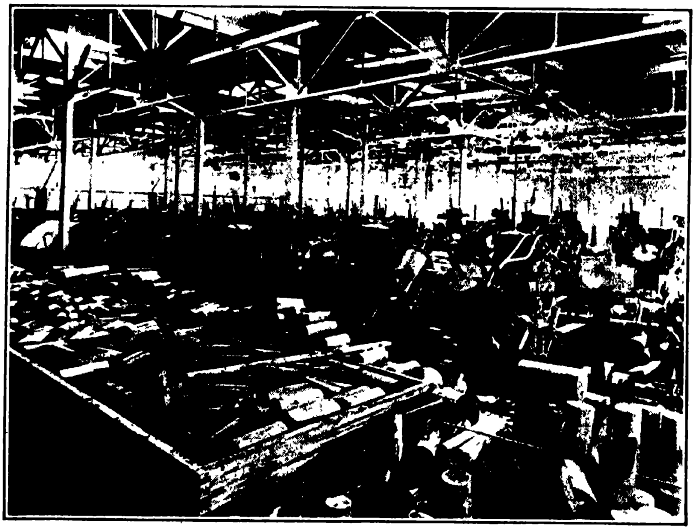


FIG. 3.—A grinder-room in a pulp mill showing the 3-pocket style of grinder which has been in use for many years.

To make 6,098,530 tons of paper in the United States in 1919, there were used 4,019,696 tons of wood pulp, 1,854,386 tons of paper stock, 353,399 tons of straw, 277,849 tons of rags, 116,994 tons of rope and jute, 106,850 tons of other fibers, 258,533 tons of China clay and nearly 140,000 tons of bleaching powder.

Some striking tendencies in the development of the industry are shown in Fig. 4.

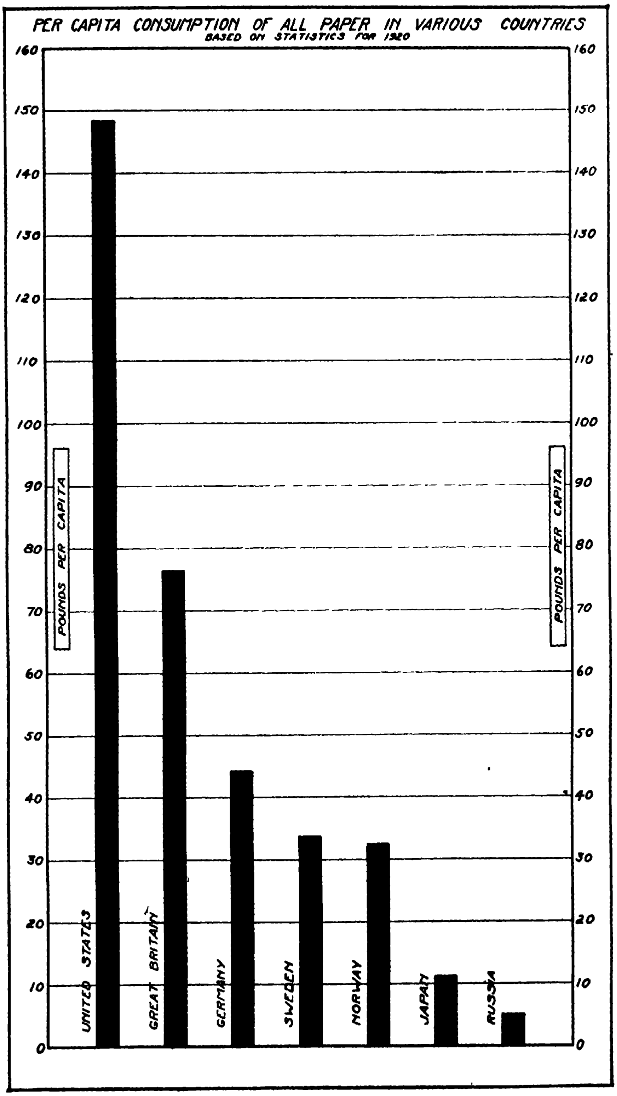


Fig. 5.—Per capita consumption of all paper in various countries, 1920.

Canada in 1921 had 100 pulp and paper mills in operation with a capital of $379,812,751, products valued at $151,003,165, using a rated horsepower of 987,984 of which 78 per cent was hydraulic and electric and 24,611 persons engaged in the industry with total salaries and wages of $34,199,090.

In round numbers, at the present time, it is safe to say that the capital invested in the North American pulp and paper industry is close to a billion and a half dollars using 3,000,000 hp. with 150,000 persons directly employed and an annual product valued at more than one billion dollars.

Capital has not been slow to respond to the demands for paper products and new developments are frequent.

Coming down to the omnipresent newspaper, a news print mill of 100 tons daily capacity is about the average size for the entire industry. At present construction costs such an establishment of completely integrated character, *i.e.*, equipped to make its own sulphite and groundwood pulp, including waterpower development and necessary working capital, will require an investment in the neighborhood of $50,000 per ton of daily product or a total of $5,000,000. And this allows nothing for the insurance of future wood supplies through the ownership of tributary timberlands. To yield steadily the amount of wood needed for such a plant the equivalent of at least 100,000 acres of well-stocked growing forest of various age-classes will be required, the ultimate investment in which may easily equal that in plant and waterpower, or another $5,000,000, making a total investment of $10,000,000 for a permanently self-contained operation.

The hasty reader who scans headlines as he is carried along in the morning and evening rush in our great cities and then carelessly casts aside the bulky newspaper which he has bought for 2 or 3 cents, has no realization of the truly modern miracle of coordination and accomplishment all the way from spruce tree in the distant forest to newsboy on the street corner which gives him at a cost so little that

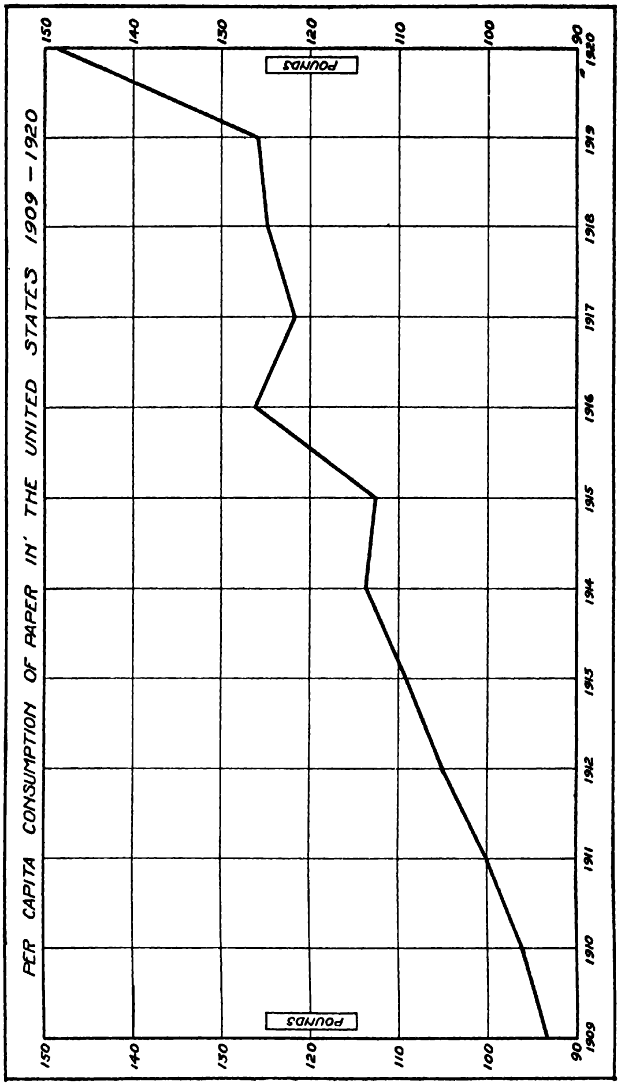


FIG. 6.—Per capita consumption of paper in the United States. 1909–1920.

he does not appreciate it a résumé up to the hour of the world's happenings in industry, politics, education, science and religion.

Political economists assure us that the so-called modern democracies could not be maintained without cheap and abundant paper and it may be asserted with equal truthfulness that a cheap and abundant supply of news print paper depends upon the application of sound forest management to the pulpwood areas of North America.

A Paper Age.—This is truly a paper age, and wide as is the variety of papers and multitudinuous the uses, there is still room for great increase in the use of paper throughout the world, if the people in other countries attain a standard of living which approaches that in the United States. Such data as are available for the year 1920 indicate an annual consumption of about 5 lb. of paper per capita in Russia, of 11 lb. in Japan, 33 lb. in Scandinavia, 45 lb. in Germany, 75 lb. in Great Britain and 148 lb. in the United States. In 1922, 45 lb. per capita of news print paper alone was used in the United States.

No "saturation point" can be predicted if the public can get cheaply and abundantly the paper it is capable of using. Increase in consumption will stop when forced by higher costs for material and labor. Figure 5 shows graphically the per capita paper consumption in various countries in 1920.

There never was paper enough in the world until it was made of wood. But little more than 30 years ago an English authority hailed the development of the use of wood as supplying an "inexhaustible source" of useful fiber for paper making. Today we know that our resources are being drawn upon too heavily and that without better forest protection and more care for reproduction the pinch of scarcity of paper-making materials will again be felt.

CHAPTER II

PROCESSES

There are four chief processes for the making of paper pulp from wood, one of which is mechanical and three chemical, the latter being distinguished as the sulphite, soda and sulphate processes.

In the *mechanical process* the barked wood in the form of short bolts is held laterally under heavy pressure with a plentiful supply of water against large, rapidly revolving grindstones which tear the fibers apart and produce a finely divided mass of pulp suitable after screening, and, in some cases bleaching, for the making of certain kinds of paper.

In the *sulphite process,* the prepared wood is finely chipped mechanically and then cooked in a closed "digester" for several hours by steam under considerable pressure in a liquor consisting chiefly of bisulphite of lime with some sulphurous acid in solution. The chemicals dissolve out all materials in the wood except the cellulose, or true wood fibers, which after washing and screening remain as so-called sulphite pulp.

In the *soda process,* the digesting agent is caustic soda, an alkali, instead of an acid, but in other ways the general procedure is similar.

The *sulphate process* is closely related to the soda process, the cooking liquor being made from sodium sulphate instead of sodium carbonate with a resulting pulp of dark color and much strength.

Expensive recovery systems for the chemicals are characteristic of the soda and sulphate process. There have been many attempts to reclaim and utilize the many compounds known to exist in waste sulphite liquor, but few have proved commercially profitable.

On an air-dry basis (10 per cent moisture) the average yield of pulp per cord of wood is commonly assumed to be one ton in the mechanical process and one-half ton in the chemical processes, but there are wide variations due to kind, quality and condition of wood, efficiency of operations and other causes. The chemical pulps are generally stronger than mechanical pulp because of the broken fibers which occur in grinding wood.

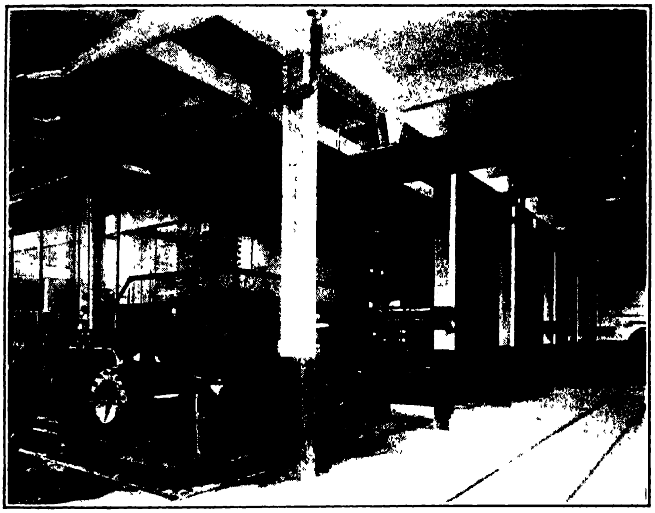


FIG. 7.—Magazine grinders in a modern pulp mill.

Mechanical Process.—During the latter part of the 18th century, experiments with wood for paper-making were undertaken in Europe, but it was not until 1844-5 that Keller in Saxony made mechanical pulp on a grindstone and sold the idea to Volter for the equivalent of a few hundred dollars. Within the next 15 to 20 years the new process developed slowly and by 1865 there were a number of pulp mills in Germany and Scandinavia that were making groundwood on a commercial scale. English patents were then taken out by Volter about this time

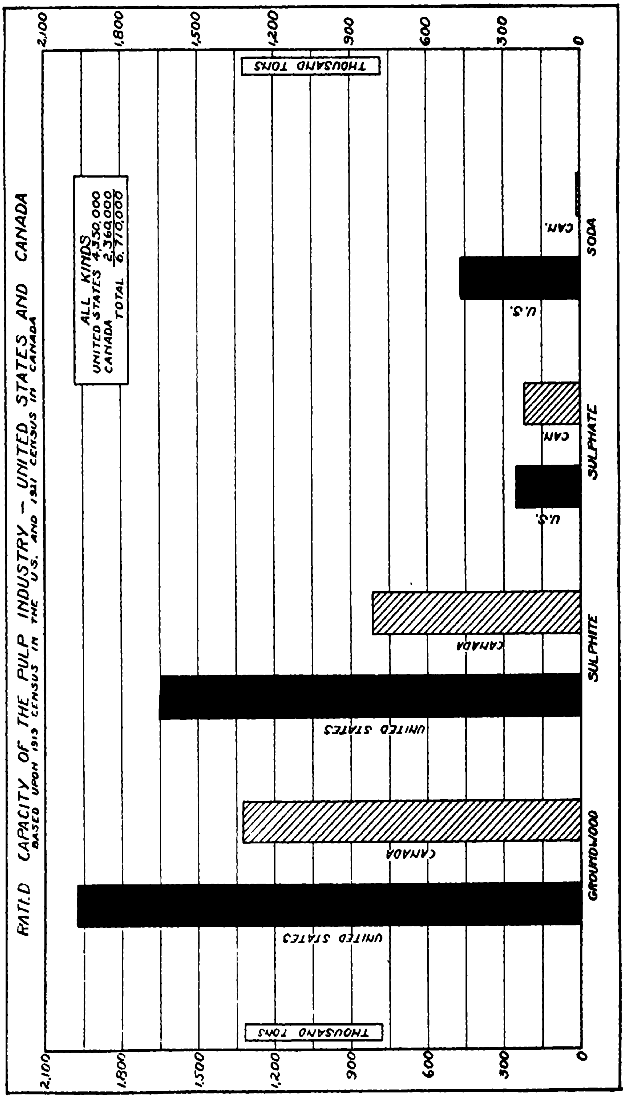


FIG. 8.—Rated capacity of the pulp industry—United States and Canada.

and it is also noted that in 1869 60 tons of mechanical pulp was exported from Norway to England—the beginning of a steady flow of such paper-making material from Scandinavia.

Historians of the paper industry record that the first mechanical pulp made commercially in the United States was by the Pagenstechers at Curtisville, near Stockbridge, Mass., in 1867 using two imported grinders with a capacity of half a ton a day. The Remington Paper Company made groundwood at Watertown, N. Y., in 1869. Another pioneer in the development of the mechanical process of pulp making was Alvah Crocker who built a mill at Turners Falls, Mass., that made from 5 to 7 tons a day of groundwood from poplar.

News print paper containing groundwood was first made in Canada by Alexander Buntin at Valleyfield, Quebec, in 1866, and these grinders were operated until some time after 1880. The census of 1881 reported five pulp mills in Canada with a total of 68 employees and a product valued at $63,000.

Improvements and extensions in the making of groundwood took place rapidly in both the United States and Canada and to this process more than to any other is due the cheap and abundant supply of paper, and particularly news print, enjoyed for the past 30 years.

Capacity of the Groundwood Mills.—Statistics upon capacity and output in any industry are of but temporary accuracy because of changes in technical processes, expansion and obsolescence of equipment, shifting markets and other factors. Nevertheless it is interesting to note that the rated capacity of the installations for making groundwood in North America is now not far from 3,600,000 tons yearly of which about 2,000,000 tons is in the United States and the balance in Canada and Newfoundland.

Not only in groundwood but also in all other kinds of wood pulp, does the capacity of the North American mills equal the mills of all the rest of the world put together.

Production, of course, can never equal rated capacity in any one year and an output in the neighborhood of 2,675,000 tons of groundwood in 1920 in North America or some 75 per cent of rated capacity was a very high one.

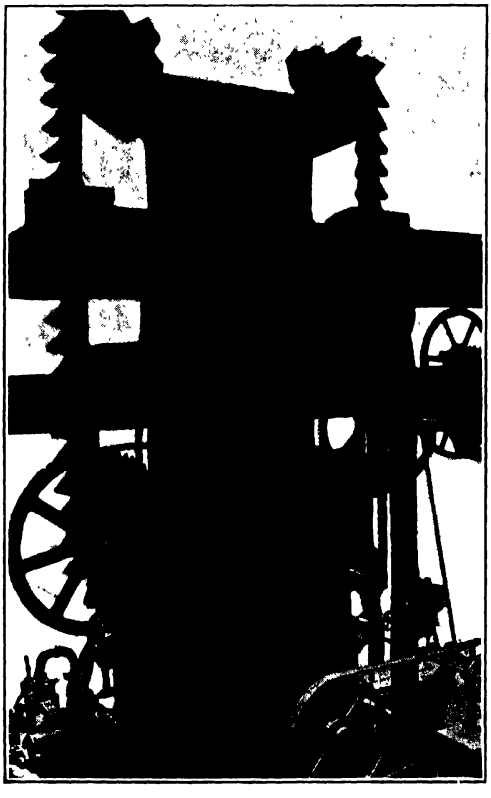


FIG. 9.—A "caterpillar" magazine grinder—one of the most recent developments.

As suggested by the great increase in capacity, there have been very great improvements in the mechanical equipment for making groundwood and in the methods of applying the large amount of power required, although from the beginning the process has simply been one of holding a bolt of wood against a rapidly revolving grindstone.

The first crude installations produced but a few hundred pounds per stone per day; the latest electric-driven three- or four-pocket or magazine grinders produce 10 to 15 tons each daily.

Location of Mills.—Cheap power in large amount has always been essential for the economical manufacture of groundwood, and for this reason, plants for the production of mechanical pulp were originally and still are chiefly located where large waterpower developments are possible. Some plants accessible at reasonable rates to high tension electric transmission lines buy power for their electrically driven grinders, but even in this case the initial source of power is the energy of falling water.

The bulk of the plants which manufacture groundwood in the United States are located in the States of New York, Maine, Wisconsin and Minnesota. About four-fifths of the present output comes from these States, with most of the remainder from Vermont, New Hampshire and the Pacific Coast.

In Canada, approximately half the present output of mechanical pulp is made in the Province of Quebec, over one-third in Ontario, and most of the balance in British Columbia.

It is usually figured that as a safe minimum, a groundwood plant should be provided with a waterpower development of at least 75 hp. per ton of daily output or that a mill of 100 tons capacity should have access to a dependable supply of 7,500 hp.

Such a plant including cost of power development, but not timber supply, might easily cost $800,000, or $8,000 per ton of daily capacity.

Views of typical groundwood installations are shown in Figs. 3, 7 and 9.

Species Used.—Spruce and balsam fir are the woods most largely used in the mechanical process although hem-

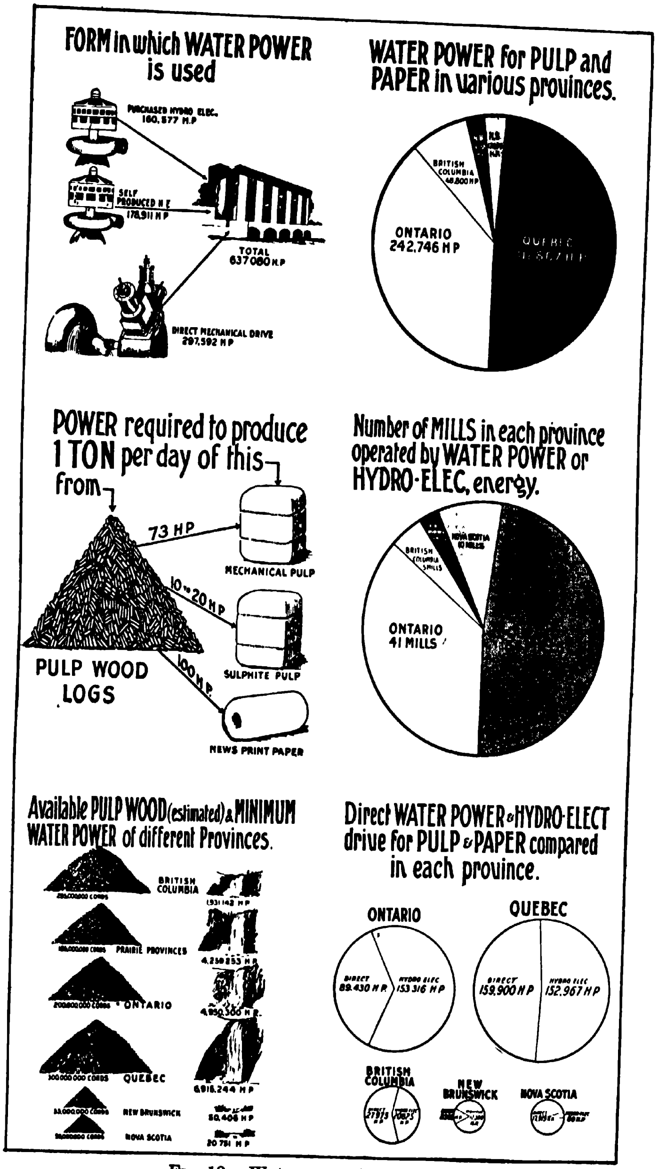


Fig. 10.—Water power in Canada.

lock, poplar, cottonwood, pine and other species always have been and still are somewhat of a factor in making groundwood. Spruce and balsam made up 93 per cent of all the wood used by the mechanical process in the United States in 1920 while in Canada the proportion of these species amounted to 98 per cent of the raw material used for groundwood. For a good mechanical pulp the essential requirements are a wood which is light in color, of even texture, with a long fiber and little resin.

The mechanical process has always made heavy demands for wood among the various processes for making wood pulp, but statistics upon the amount of wood used for this purpose are by no means complete. Not far from 600,000 cords of wood must have been reduced by the mechanical process in the United States in 1899, and nearly 1,600,000 cords in 1920. In Canada, some 300,000 cords of wood was used in the mechanical process in 1908, the first year for which there are figures upon groundwood output, while in 1922 the amount reported was 1,215,000 cords. In 1908, 37 per cent of all the pulpwood used in North America went into groundwood and in 1920, 30 per cent of the total was used for the same purpose.

It is probably safe to say that since the mechanical process was introduced into America not less than 32,000,000 cords of wood have been used for this purpose in the United States and 15,000,000 cords in Canada—a total of 47,000,000 cords from which an equal number of tons of groundwood was produced.

At the present stage of development, there is more capacity for the production of groundwood in North America than in all other countries of the world combined. Other regions of some consequence in the making of groundwood are Germany, Sweden, Norway, Finland and Czecho-Slovakia, ranking in about the order named, according to rated capacities in the directories.

Uses of Groundwood.—Ever since the making of pulp mechanically from wood began, groundwood has been a

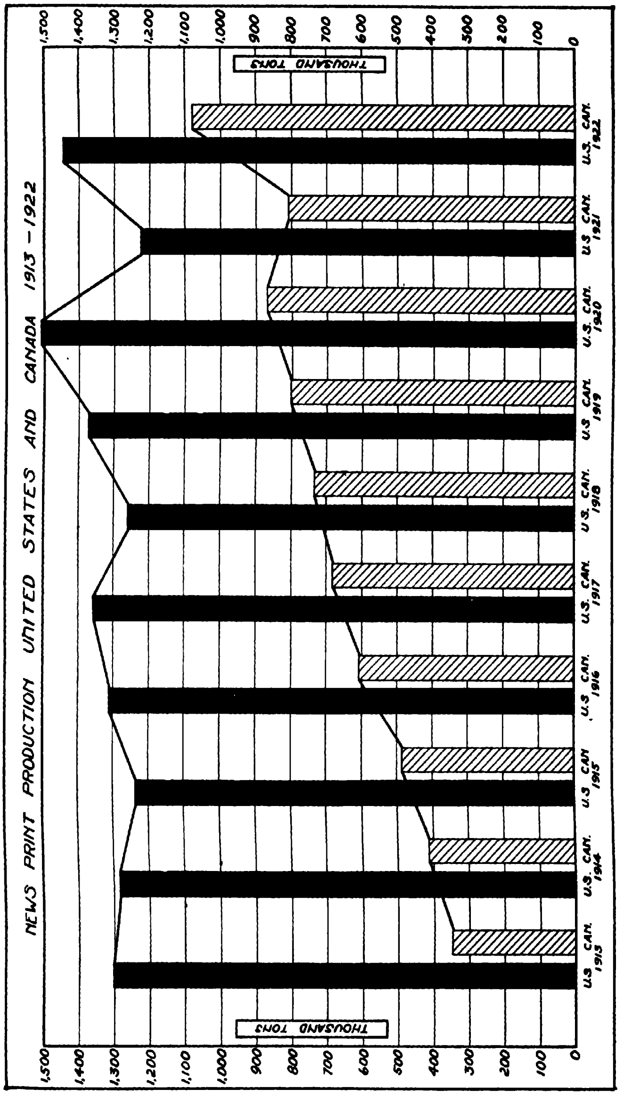


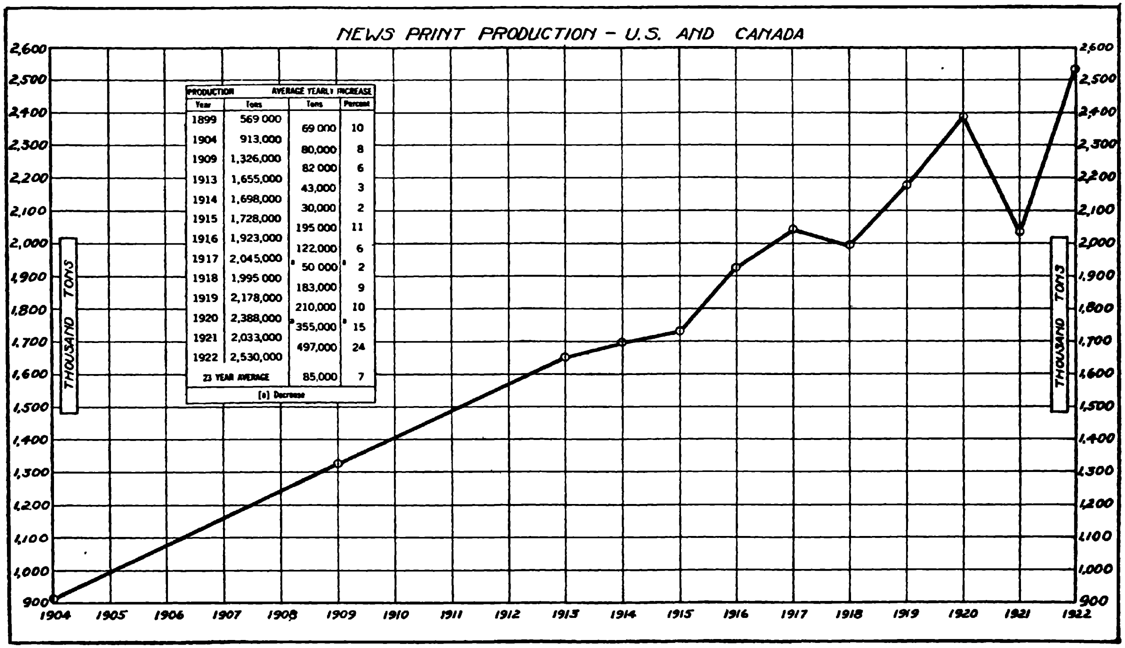
FIG. 11.—News print production, United States and Canada, 1913-1923.

determining factor in the production of cheap paper. The first mechanical pulp made at the Curtisville mill sold for 8 cents a pound on a bone-dry basis, but the price soon went lower and eventually down less than one cent a pound. A price at the mill ranging from $25 to $45 per ton on an air-dry basis (10 per cent moisture) has been common for a long time, with the exception of temporary run-away periods, the most notable of which was in 1920 when some groundwood was sold for $140 per ton f.o.b. mill.

Groundwood is the chief constituent of news print paper, and large supplies have made possible the great expansion in the production of news print in the United States and Canada, shown graphically in Fig. 11 and Fig. 12. There has been an average yearly compounded increase of 7 per cent in news print production since 1899 until now the capacity of the North American news print mills is approximately 9,500 tons per day, of which 5,150 tons is in the United States and the balance in Canada and Newfoundland. Should additional Canadian developments now under consideration take place the capacity to make news print in Canada will equal that in the United States by 1925. Four-fifths of the news print paper made in Canada in 1922 was marketed in the United States.

The United States uses more news print paper than all the rest of the world combined with a consumption in 1922 of 45 lb. per capita. The circulation of the Sunday newspapers is about 20,000,000 copies and of the dailies more than 30,000,000 copies but the reader who scans headlines and casts his paper lightly aside seldom realizes that he is handling a 100 per cent forest product just as truly as if he had picked up a board or a baseball bat.

News print paper averages in composition about 80 per cent groundwood and 20 per cent sulphite pulp, although there are variations in both directions depending upon quality of material, availability of supply and other factors. Not less than 70 per cent of all the mechanical pulp made



PRODUCTION		AVERAGE YEARLY INCREASE	
Year	Tons	Tons	Percent
1899	569 000		
		69 000	10
1904	913,000		
		80,000	8
1909	1,326,000		
		82 000	6
1913	1,655,000		
		43,000	3
1914	1,698,000		
		30,000	2
1915	1,728,000		
		195 000	11
1916	1,923,000		
		122,000	6
1917	2,045,000		
		[a] 50 000	[a] 2
1918	1,995 000		
		183,000	9
1919	2,178,000		
		210,000	10
1920	2,388,000		
		[a] 355,000	[a] 15
1921	2,033,000		
		497,000	24
1922	2,530,000		
23 YEAR AVERAGE		85,000	7

[a] Decrease

FIG. 12.—News print production, United States and Canada, 1904–1922.

in North America goes into news print paper, or at the present rate of consumption around 2,000,000 tons yearly.

Next to news print, the most important uses of mechanical pulp are for hanging (wall paper), paper board, book paper, and other cheap printing papers of better quality than news print.

Sulphite Process.—A process for making pulp by boiling wood in a sulphur dioxide solution was developed by Tilghman in Philadelphia shortly after the Civil War and patented by him in England in 1866-7. He applied this method to spruce, hemlock, poplar and willow, but he did not bring it to a commercial success.

The first real sulphite mill was started in Sweden by Ekman in 1874 who used a rotary digester and indirect heat by means of a steam jacket. The Mitscherlich process, similar to that of Tilghman, was developed in Germany about 1880. This was also an indirect cooking process. A direct cooking process was effected in Austria in 1878 by Ritter and Kellner and was introduced into Canada—Merriton, Ontario—in 1885 by Russel and Riordon.

The Ekman process was brought to Providence, R. I., by Wheelwright in the early 80's and the Mitscherlich process was soon thereafter installed in the Fletcher mill at Alpena, Mich.

After the introduction of these sulphite processes into America, progress was rapid and in a few years large quantities of the new pulp were available for the uses of the paper maker.

The first United States Census to report separately the quantities of the different kinds of wood pulp manufactured was for the calendar year 1899 when the total for sulphite was 416,000 tons. This was 71 per cent as much sulphite pulp in tons as was made by the mechanical process in that year, and required more than 800,000 cords of wood for its production or approximately a quarter of a million more cords of wood than was used for groundwood in 1899.

Development of the sulphite process in the United States continued at a rapid rate and in 1909 the output was more than a million tons—a gain of 144 per cent in 10 years. In another ten years the production of sulphite pulp went to 1,420,000 tons—a gain of 40 per cent for the period, and in 1920 with 1,586,000 tons, the sulphite pulp production slightly surpassed that of groundwood in the United States.

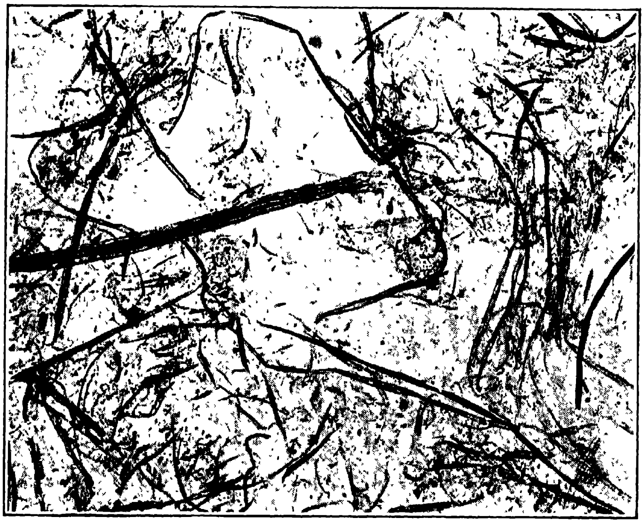


Fig. 13.—Mechanical pulp. Spruce fibers greatly magnified.

In the 2 years following 1920, the sulphite output fell off heavily due to the importation of large quantities of cheap European pulp.

During the earlier period, the manufacture of sulphite pulp did not make such relatively rapid strides in Canada as in the United States, and in 1908, the first year for which figures are available, the output was 82,000 tons. Progress was swifter thereafter and in 1918 the total was 494,000 tons—a gain of 500 per cent in 10 years. A high point of 676,000 tons was reached in 1920 followed by a temporary decline similar to that in the United States.

The sulphite process is now widely and evenly distributed throughout the paper-making regions of North America, since its product is in wide demand and unlike the mechanical process, the location of plants is not dependent upon waterpower development.

The determining factors in the location of mills to make chemical fiber are wood supply and the market for pulp.

Since the sulphite process was introduced into the United States probably not less than 25,500,000 tons of sulphite pulp has been produced requiring at least 51,000,000 cords of wood. In Canada, during the same period the production of sulphite pulp has been something like 5,500,000 tons made from approximately 11,000,000 cords of wood a total for the two countries combined of 31,000,000 tons of pulp requiring 62,000,000 cords of pulpwood.

Typical sulphite mill scenes are shown in Figs. 26, 27 and the statistics of production graphically exhibited in Figs. 14, 18.

Capacity of the Sulphite Mills.—The rated capacity of the sulphite mills in the United States, according to Census reports, grew from 885,000 tons in 1904 to 1,656,000 tons in 1919. The actual production in the former year was 85 per cent of the rated capacity and in the latter year 93 per cent. Since sulphite mills require little power and can generally operate the year round, but little excess capacity is needed. Most groundwood mills on the other hand, depend upon water for the large amount of power needed, and due to the seasonal variations in streams, must be equipped to produce as much pulp as possible during the periods of maximum flow.

The rated capacity of the Canadian sulphite mills was 682,000 tons in 1919 with an actual output of 82 per cent of that amount.

There have recently been material additions to the Canadian sulphite mills so that the rated capacity for North America is now in the neighborhood of 2,500,000 tons

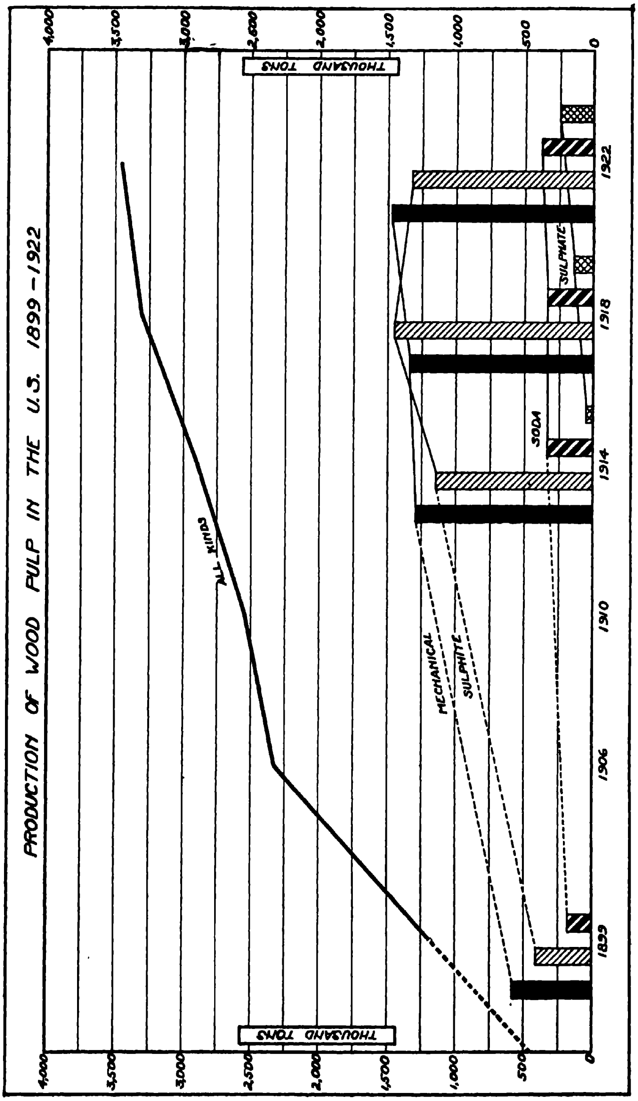


FIG. 14.—Production of wood pulp in the United States, 1899–1922.

—a tonnage equal to that of the sulphite mills in all other countries combined.

Outside of America, the only other important sulphite pulp-producing countries are Sweden, Germany, Norway, Finland and Czecho-Slovakia ranking approximately in the order named.

Fig. 15.—The only pulp mill in Alaska. Rated capacity 15 tons of groundwood daily.

Species Used.—The variety of woods used commercially for the manufacture of sulphite pulp is more restricted than that in any other process. In the United States, for example, spruce and balsam fir made up 70 per cent and hemlock 24 per cent of the 3,200,000 cords of wood used for sulphite pulp in 1920, while in Canada spruce and

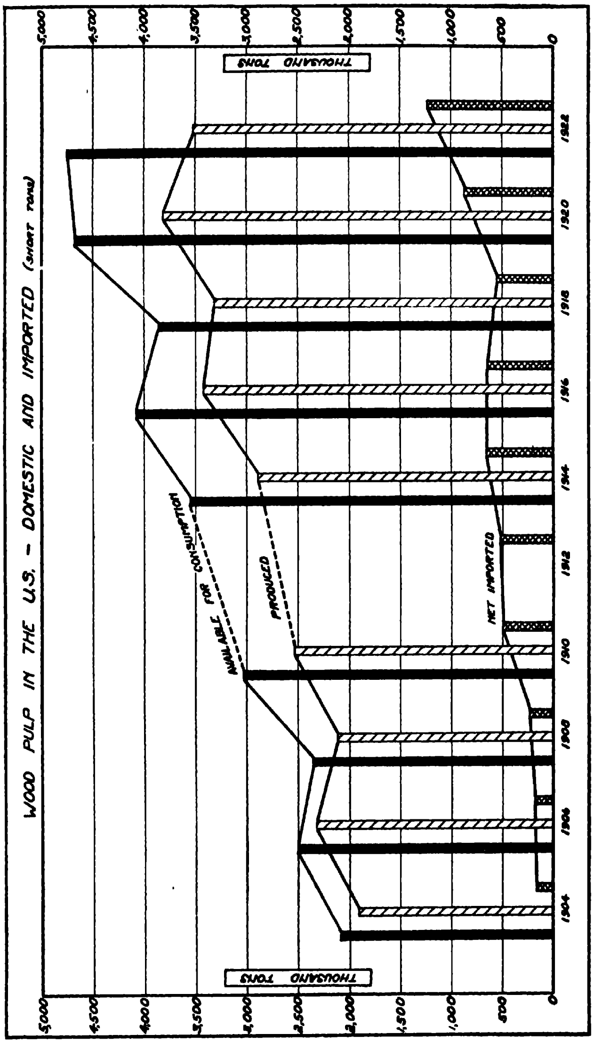


Fig. 16.—Wood pulp in the United States—domestic and imported.

balsam fir amounted to 90 per cent and hemlock to almost 10 per cent of the 1,354,000 cords of wood used for the same purpose in that year. Other woods used to a small extent for sulphite pulp are white fir, tamarack and yellow pine, the white fir being a western species of the same genus as the eastern balsam fir.

Originally applied to spruce, the sulphite process has been the means of best making available for pulp relatively large quantities of hemlock and balsam fir timber and thus adding greatly to the supply of paper-making material.

Since 1905, the first year for which such details are available, more than half the pulpwood used in the United States has gone into paper via the sulphite process. While Canadian figures have been collected for a much shorter period, the reports indicate that since 1917 from 41 to 49 per cent of all the pulpwood used in Canada has been made into sulphite pulp, and that an average of perhaps 100,000 more cords per year has been used for the last six years for sulphite than for groundwood.

In 1905, the sulphite mills in the United States used 1,630,000 cords of wood. In 1907 the amount exceeded 2,000,000 cords, with a dropping off of some 300,000 cords in 1908, following the business depression which started in the fall of 1907. By 1918 the use of pulpwood for sulphite had grown to 2,860,000 cords and a peak of 3,200,000 cords was reached in 1920, which was nearly 300,000 cords more than the combined amount of wood used for mechanical, soda and sulphate pulp in the United States in that year.

A high mark for the Canadian sulphite mills was reached in 1920 when 1,354,000 cords of wood was used. The business depression of 1921, together with the importation of cheap foreign sulphite into the United States caused a decrease of some 370,000 cords of wood used in the Canadian sulphite industry in 1921 over the high record of 1920.

The market value of domestic unbleached sulphite pulp has ranged from $35 to $65 per ton f.o.b. mill over a considerable period of time, excluding the abnormal situation for a little while in 1920 when some sulphite pulp sold as high as $180 per ton. Sulphite is, of course, very much more expensive to make than groundwood because of the equipment, the chemicals required, and the fact that it takes twice as much raw material in the shape of wood per ton of pulp produced. For rough and ready figuring, the usual calculation is two cords of prepared wood per ton of chemical pulp.

A modern 50-ton sulphite pulp mill will cost from $800,000 to $1,000,000 or about $18,000 per ton of daily capacity, without any investment in timber supply or allowance for working capital.

Incidentally it may be noted that on the average about 270 lb. of sulphur and 300 lb. of limestone are used for each ton of pulp produced.

Uses of Sulphite Pulp.—Sulphite pulp has a wide diversity of uses. It makes up, on the average, about 20 per cent of the composition of news print paper so that at the present rate of production about 500,000 tons of sulphite is required by the news print mills of North America, the most of which have their own sulphite-producing plants. Sulphite pulp goes largely into paper board, wrapping, book and writing papers, either wholly or in mixture with other wood or rag pulps. It is also used in tissue and cover papers, and in recent years, a special grade of bleached sulphite pulp is coming widely into use for much the same purposes as absorbent cotton. Bleached sulphite goes regularly to mills which convert it into the so-called "fiber silk" and thence into many articles of wearing apparel.

Since bleached sulphite pulp is practically pure cellulose, it can also be used in the manufacture of guncotton, celluloid and other products for which cotton is generally the base.

Soda Process.—Although the soda process was the first one for making paper pulp from wood to be tried in the United States, it did not come rapidly into vogue, nor has it ever attained comparatively large proportions. Soda pulp was made commercially in the United States in 1854 near Philadelphia after the Burgess patent (English), but has been mostly developed since 1880.

The cooking material is caustic soda which is better adapted to the broad-leaved species of timber than is the sulphite process. Soda pulp finds its chief use as a constituent in book papers. It has neither a long nor a strong fiber because of the kinds of wood used, but is an excellent filler with stronger chemical or rag fibers and is valuable in contributing to a good printing surface.

Fig. 17.—The most northern paper mill in America. A mill of 250 tons daily capacity in British Columbia.

Soda pulp plants are more expensive than sulphite plants since, because of the high value of the chemical used (600-700 lb. of soda ash per cord of wood), a recovery system is installed in which the waste cooking liquor is condensed by evaporation and then burned to yield a crude sodium carbonate.

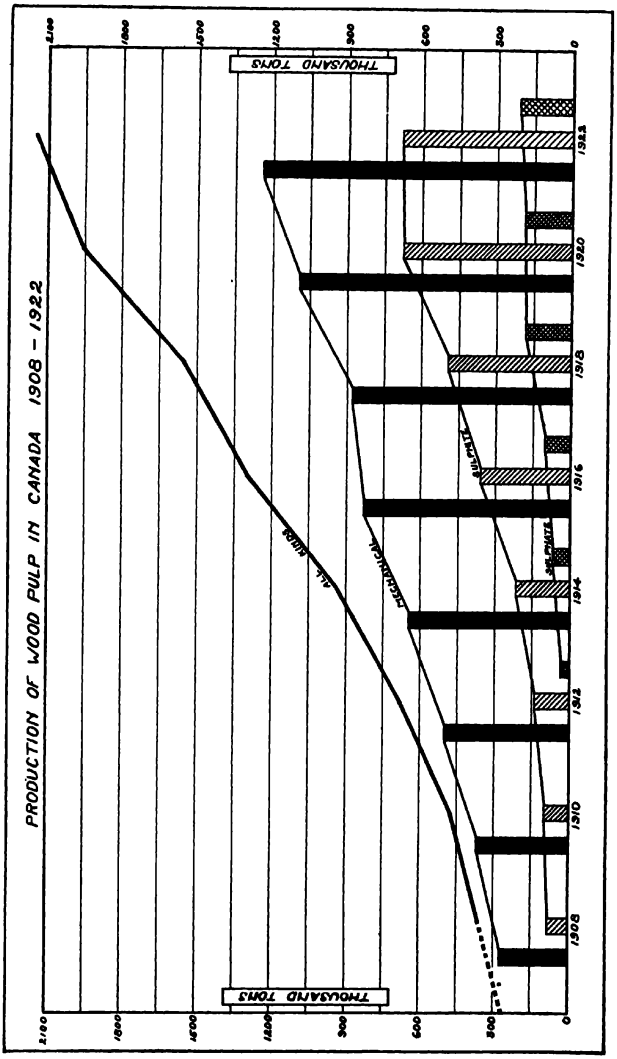


Fig. 18.—Production of wood pulp in Canada, 1908–1922.

Under present conditions a complete 50-ton soda plant, including bleaching equipment, will cost in the neighborhood of $1,250,000 or about $25,000 per ton of daily capacity to make pulp.

The rated capacity of the soda pulp mills in the United States runs around 500,000 tons yearly with a maximum production in 1920 a little in excess of 460,000 tons. The first soda pulp in Canada was made at Windsor Mills, Que., in 1864, but the industry has never been of much size in the Dominion, and the production in 1920 was less than 6,000 tons.

For all practical purposes, the manufacture of soda pulp is confined at present to the United States and Germany, with the rated capacity of the German soda mills less than one-quarter of those in the United States.

The earliest Census reports which give information upon the tonnage of soda pulp produced in the United States are for the year 1899 when the industry had already attained an output of 177,000 tons. During the following 10 years there was a growth of 68 per cent with a production only a little short of 300,000 tons in 1909. In the next decade the growth was 38 per cent with an output of 412,000 tons in 1919 which went to a maximum of 463,000 tons in 1920, dropped back to 301,000 tons in 1921 and increased to 420,000 tons in 1922.

Location of Mills.—Soda pulp mills are by no means so widely distributed as those for the making of either mechanical or sulphite pulp. Nearly two-thirds of the output comes from Pennsylvania, Maine and New York in the order named with a considerable production in North Carolina, and lesser amounts in several other states.

Almost all of the small Canadian production of soda pulp is in the province of Quebec.

Disregarding the abnormal conditions of 1920, the market value of soda pulp has ranged from $65 to $90 per ton during recent years.

Species Used.—On the average, it requires two cords of wood to make a ton of soda pulp, and while statistical totals are largely lacking, the reports indicate that in 1905 there was used about 465,000 cords of wood for soda fiber in the United States which increased in the ratio noted for soda pulp output until a maximum of 924,000 cords was reached in 1920.

Since the introduction of the process of separating cellulose from the other constituents of wood through boiling in a caustic soda solution, it is probable that not less than 7,500,000 tons of such pulp has been produced in North America, for which some 15,000,000 cords of wood was used.

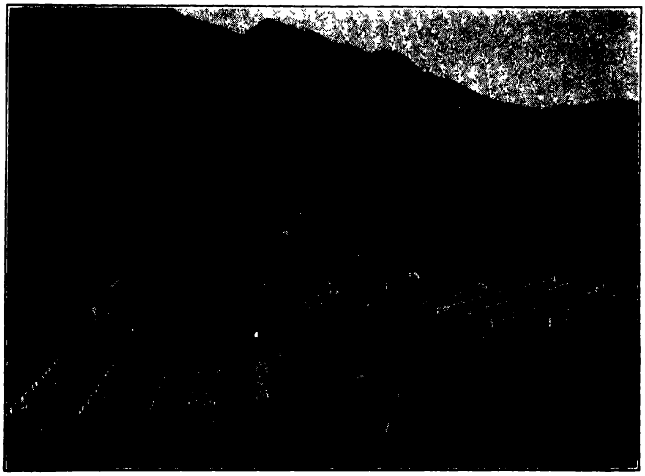


FIG. 19.—The only complete modern pulp and paper mill in Mexico.

As already suggested, the soda process can be successfully used with a larger range of woods than the other processes because it can be applied to both the coniferous and broad-leaved species, while the mechanical, sulphite and sulphate processes are chiefly employed for coniferous woods. With the exception of yellow pine, however, the soda process is used chiefly with the broad-leaved species, and these species made up four-fifths of all the wood converted into paper pulp by the soda process in 1920 in the United States.

Poplar (aspen) has always been the most important wood for soda pulp and originally little else was used for this purpose. This species still supplies nearly 40 per cent of the total requirements of the soda pulp mills. Other hardwoods commonly used are yellow poplar (tulip tree), gum, beech, birch, maple, cottonwood, basswood, etc. Yellow pine to the amount of 147,000 cords was used in 1920, but no large quantities of other softwoods found their way into the soda mills. Douglas fir is used for soda pulp to some extent on the Pacific Coast.

Sulphate Process.—This is a modification of the soda process through the substitution of sodium sulphate for the more expensive sodium carbonate. It was introduced by Dahl in Danzig in 1883 and first applied to straw but soon thereafter to wood.

The first sulphate installation in North America was that of the Brompton Company at East Angus, Quebec, in 1907, and the process was soon afterward introduced into the United States.

Since that time the development of the industry has been comparatively rapid. Sulphate pulp (now generally called kraft) goes largely into wrapping, cover and other paper in which strength in proportion to weight is important and in which a dark color is not a detriment. In recent years, quite a little sulphate pulp has also been bleached.

At the present time, the pulp-producing capacity of the sulphate mills in North America is not far from 500,000 tons yearly—about equally divided between the United States and Canada. The growth of the sulphate industry in America has been so rapid that it is now about equal to the European industry where the leading countries in

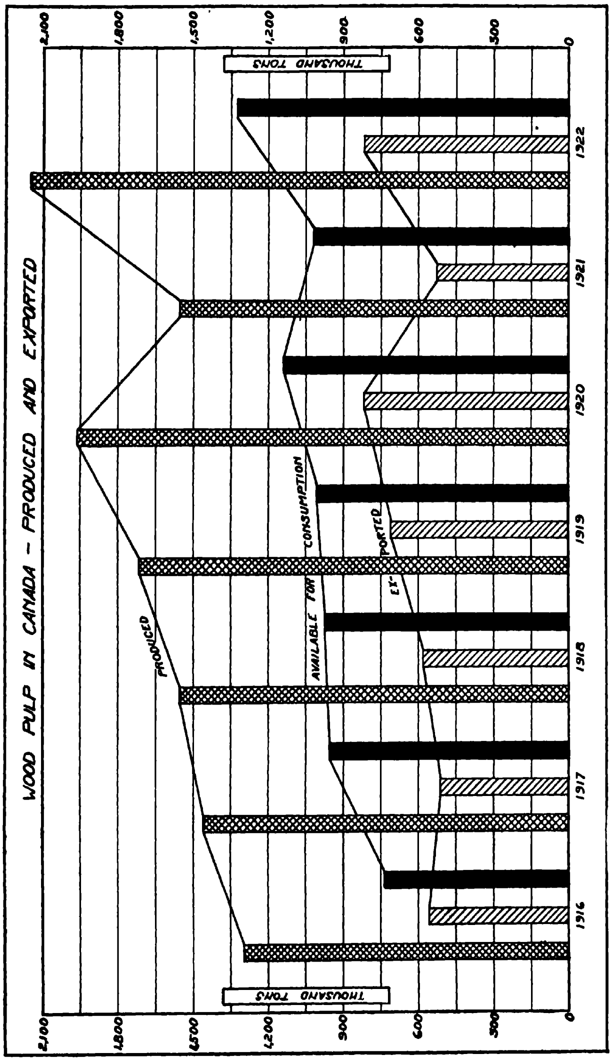


Fig. 20.—Wood pulp in Canada—produced and exported.

the manufacture of this form of chemical wood pulp are Sweden, Germany, Finland and Norway.

The cost of a sulphate mill is about the same as for a soda mill except that bleaching apparatus is not usually provided in a sulphate mill.

The first Census report upon the production of sulphate pulp in the United States was for the year 1914 when an output of nearly 53,000 tons was noted. In 1918 the production was 142,000 tons or a growth of 167 per cent in 4 years, while in 1922 there was 244,000 tons of sulphate pulp made in the United States or almost five times the output 8 years earlier.

The first separate figures reported upon the production of sulphate pulp in Canada are for the year 1912 with 33,000 tons, although it is likely that a large proportion of the 24,000 tons credited to the soda process in 1911 was in reality sulphate pulp, since the normal production of soda pulp in Canada is not far from 4,000 tons.

Sulphate production in Canada doubled in 1913 over 1912, went to 100,000 tons in 1916 and to 188,000 tons in 1920, dropping back to 131,000 tons in 1921 and rising to 218,000 tons in 1922, making the combined output in the United States and Canada that year 460,000 tons.

An average of two cords of wood per ton of pulp is required for the sulphate process. Since its introduction into North America, it is a fair assumption that 1,500,000 tons of sulphate pulp has been made in Canada and nearly as much in the United States, a total for the Continent of about 3,000,000 tons into which there went 6,000,000 cords of pulpwood.

Location of Mills.—In 1920, Wisconsin was far in the lead among the States in the production of sulphate pulp, followed by Maine, Michigan, Virginia, North Carolina and other Southern States. In the same year 79 per cent of the 188,000 tons of sulphate pulp reported for Canada was made in the province of Quebec, with the balance fairly well distributed between Ontario, British Columbia and New Brunswick.

There is a recent distinct movement of considerable magnitude in the way of development of sulphate mills in the southern states and it is not unreasonable to expect that a large proportion of the kraft paper made in the United States may some day come from this region.

Species Used.—Practically all sulphate pulp is made from coniferous woods. For example, of the 396,000 cords used in the United States in 1920 for this purpose 40 per cent was southern pine, 28 per cent was spruce and balsam, 12 per cent was tamarack, 11 per cent was hemlock and 7 per cent was jack pine.

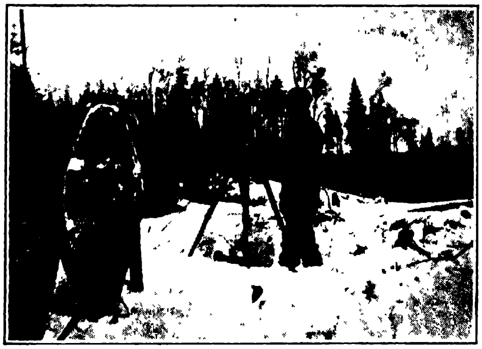


FIG. 21.—Laying out the site for a great paper mill in Canada.

In Canada in the same year 89 per cent of the sulphate pulp was made from spruce and balsam fir and 9 per cent from hemlock and jack pine. Students of the industry are predicting a considerable expansion in the manufacture of sulphate pulp in the southern states where relatively large quantities of yellow pine pulpwood are available at reasonable prices.

The price of domestic sulphate pulp during recent years has ranged from $40 to $70 per ton f.o.b. mill, omitting the abnormal situation in 1920.

CHAPTER III

CONSUMPTION OF WOOD PULP IN NORTH AMERICA

United States.—For the past quarter century, the paper industry in the United States has used each year the equivalent of all the domestic wood pulp produced plus hundreds of thousands of tons of pulp imported from Canada and Europe.

In 1899, domestic pulp production amounted to 1,180,000 tons with net imports of only 55,000 tons. Five years later, production had grown to 1,922,000 tons and imports to 169,000 tons, or three times the amount in 1904 that they were in 1899.

In 1910, with a production of 2,534,000 tons of all kind of wood pulp in the United States, imports were 498,000 tons in excess of exports, or 16 per cent of the total consumption for the manufacture of paper. Net imports of 663,000 tons in 1914 and of 874,000 tons in 1920 were in both instances 19 per cent of the total amounts of wood pulp available for consumption in those years.

Sources of Imported Pulp.—Taking all kinds of wood pulp together, imports into the United States in the 17 years 1905-1921 inclusive totaled, in round numbers, 8,635,000 tons, of which 5,360,000 tons or 62 per cent came from Canada, 1,567,000 tons or 18 per cent from Sweden, 10 per cent from Norway, 7 per cent from Germany, and the balance chiefly from Austria-Hungary and Finland.

The peak of importations of Canadian wood pulp into the United States was reached in the boom year of 1920 with 655,000 tons which dropped to 403,000 tons in 1921 due to the combined effect of the business deflation and increased importations of cheap European pulp. In 1922,

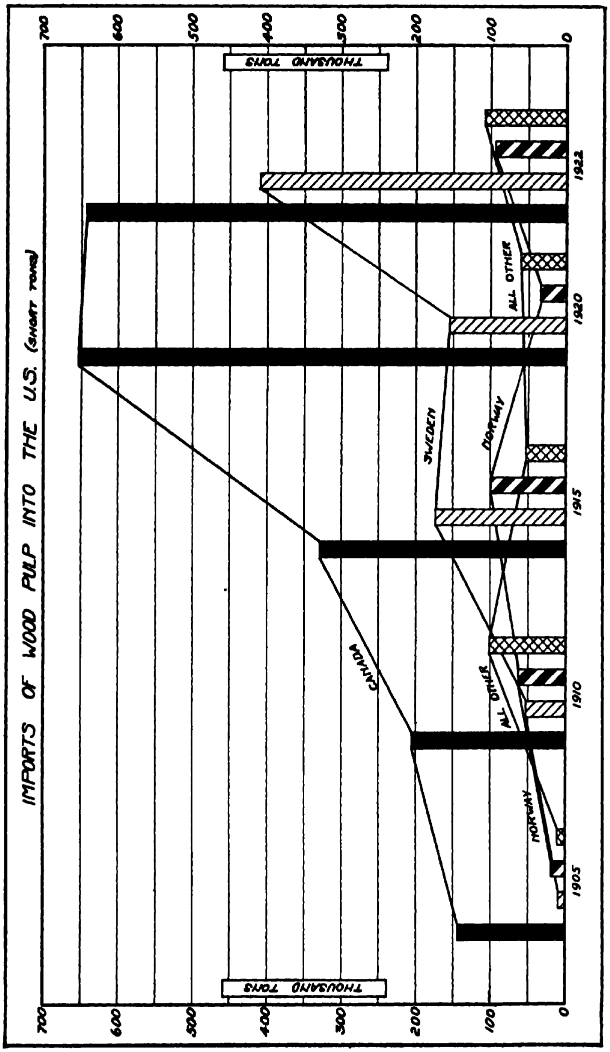


Fig. 22.—Imports of wood pulp into the United States, 1905–1922.

however, the paper mills in the United States got 645,000 tons of Canadian pulp, which indicated a return toward more normal conditions.

It is only since 1909 that there are figures upon the importation of mechanical pulp into the United States and since 1917 upon chemical pulp. In the 13 years from 1909 to 1921 inclusive there were importations of 2,665,000 tons of groundwood of which 94 per cent came from Canada with small amounts from Norway, Sweden, Finland and other countries.

In sulphite pulp the Scandinavian countries are stronger competitors with Canada for the United States market than they are in mechanical pulp. During the 5 years of 1917-1921 inclusive, total imports of bleached and unbleached sulphite pulp (19 per cent was bleached) amounted to 1,718,000 tons of which 1,087,000 tons or 63 per cent came from Canada, 443,000 tons or 26 per cent from Sweden, about 4 per cent from Norway and the balance in smaller quantities from several other countries. During recent years, a large proportion of the bleached sulphite imported into the United States has come from Canada.

Of the 768,000 tons of sulphate pulp imported into the United States during the period 1917-1921, Canada supplied 549,000 tons or 71 per cent, Sweden 177,000 tons or 23 per cent, with the balance coming from Finland and Norway.

The relationship of production and imports to consumption of wood pulp in the United States from 1904 to 1922 is shown graphically in Fig. 16.

Canada.—The wood pulp situation in Canada has been exactly the reverse of that in the United States. Canada has long been a heavy exporter of wood pulp, chiefly to the United States, although essential statistics are available for only recent years. In 1908, out of a production of 363,000 tons of wood pulp, Canada exported nearly 240,000 tons or 66 per cent of the total. With steadily increasing

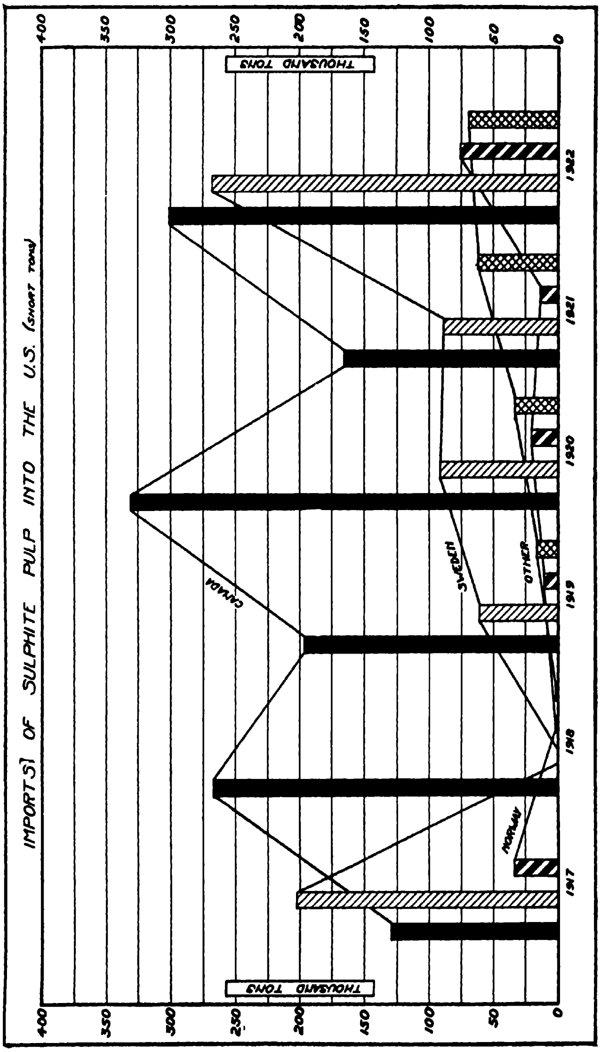


FIG. 23.—Imports of sulphite pulp into the United States, 1917–1922.

however, the paper mills in the United States got 645,000 tons of Canadian pulp, which indicated a return toward more normal conditions.

It is only since 1909 that there are figures upon the importation of mechanical pulp into the United States and since 1917 upon chemical pulp. In the 13 years from 1909 to 1921 inclusive there were importations of 2,665,000 tons of groundwood of which 94 per cent came from Canada with small amounts from Norway, Sweden, Finland and other countries.

In sulphite pulp the Scandinavian countries are stronger competitors with Canada for the United States market than they are in mechanical pulp. During the 5 years of 1917-1921 inclusive, total imports of bleached and unbleached sulphite pulp (19 per cent was bleached) amounted to 1,718,000 tons of which 1,087,000 tons or 63 per cent came from Canada, 443,000 tons or 26 per cent from Sweden, about 4 per cent from Norway and the balance in smaller quantities from several other countries. During recent years, a large proportion of the bleached sulphite imported into the United States has come from Canada.

Of the 768,000 tons of sulphate pulp imported into the United States during the period 1917-1921, Canada supplied 549,000 tons or 71 per cent, Sweden 177,000 tons or 23 per cent, with the balance coming from Finland and Norway.

The relationship of production and imports to consumption of wood pulp in the United States from 1904 to 1922 is shown graphically in Fig. 16.

Canada.—The wood pulp situation in Canada has been exactly the reverse of that in the United States. Canada has long been a heavy exporter of wood pulp, chiefly to the United States, although essential statistics are available for only recent years. In 1908, out of a production of 363,000 tons of wood pulp, Canada exported nearly 240,000 tons or 66 per cent of the total. With steadily increasing

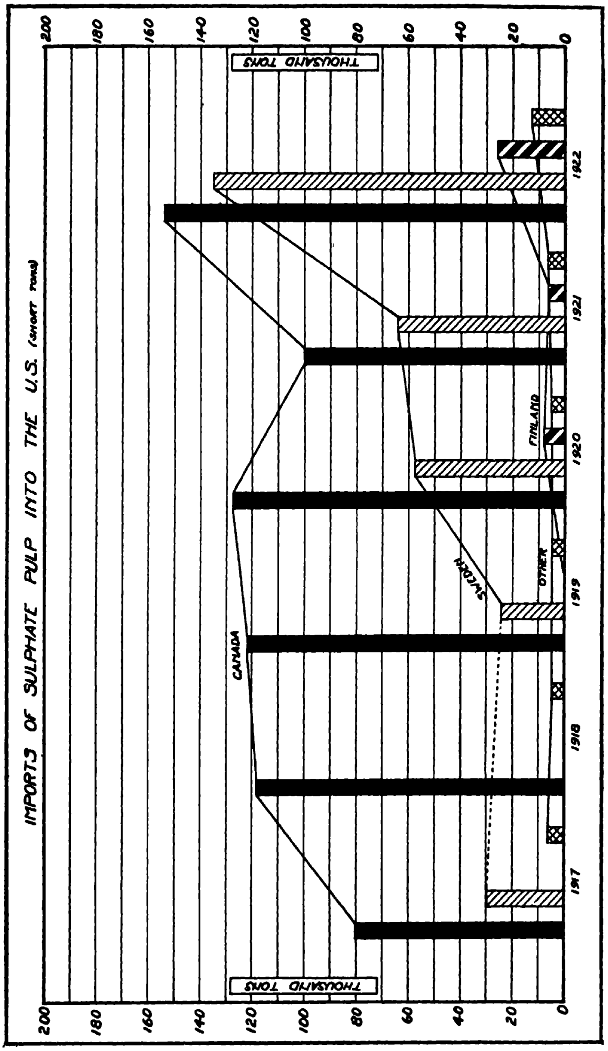


FIG. 24.—Imports of sulphate pulp into the United States, 1917–1922.

small exports to various other countries accounting for the balance.

In 1918, the value of Canadian exports of wood pulp amounted to $28,573,879 for chemical pulp and to $4,786,044 for mechanical pulp, a total of $33,359,923 or more than eight times the value of exports of the same kind 10 years earlier.

The heavy demand and extraordinary prices of 1920 brought the value of exports of wood pulp from Canada up to $76,383,978 which slumped to $33,133,675 in 1921 and rose to $41,047,849 in 1922.

During recent years from 80 to 90 per cent of the exports of Canadian wood pulp has gone to the United States with the balance chiefly to the United Kingdom and Japan.

In the 33 years from 1890 to 1923, wood pulp to a total value of $355,977,762 has been exported from Canada. This highly useful forest product has been a great factor in the development and prosperity of the Dominion.

Paper Production.—Probably 90 per cent of the total tonnage of paper made in North America is composed of wood pulp, the principal other constituents being rags and old papers. There were nearly 7,200,000 tons of wood pulp available for consumption in the United States, Canada and Newfoundland in 1922, and it is interesting to note that the combined production of paper in that year was 8,450,000 tons divided as follows:

	Tons
News print	2,590,000
Boards	2,270,000
Book and writing	1,410,000
Wrapping	920,000
Other grades	1,260,000
Total	8,450,000

The United States and Canadian figures are shown graphically in Fig. 25 for the year 1922.

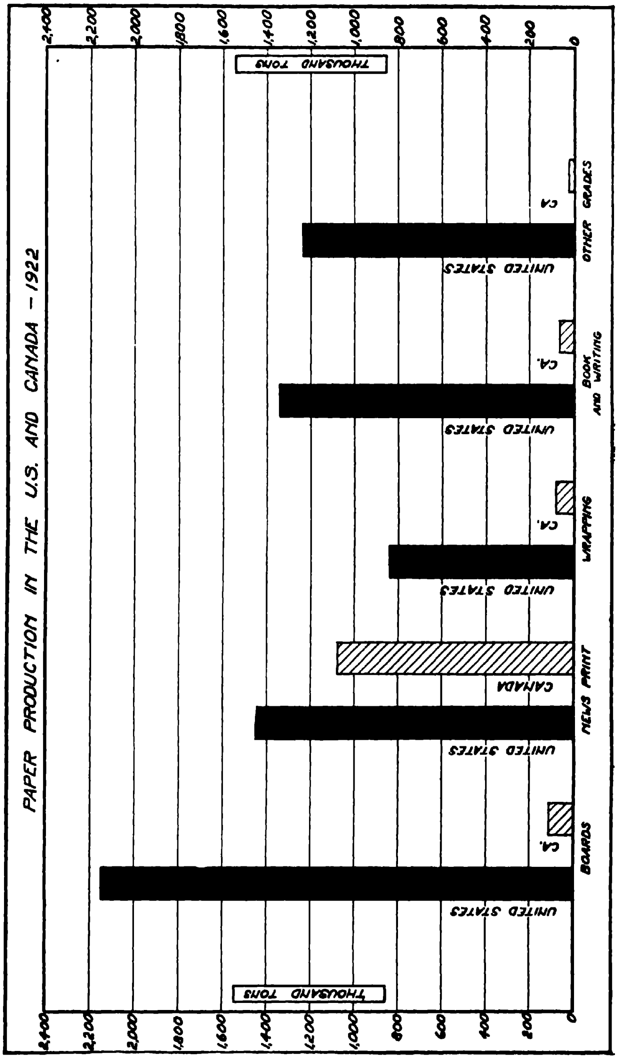


FIG. 25.—Paper production in the United States and Canada, 1922.

PART II

PULPWOODS

CHAPTER IV

LOGGING

We must go to the woods for the first steps in the manufacture of most of the paper made in North America.

The cutting of a single tree is a simple matter but the felling of a forest and the transportation of thousands of tree trunks to a mill is an undertaking extending over a long period of time and involving a surprising number of auxiliary enterprises which vary with kind and size of timber, topography, climate, distance from point of utilization, type of forest ownership and local usage.

A primary requisite is the determination of the size of the working unit, the quantity of timber involved, its location upon various watersheds, the amount to be taken out at each point and the probable costs. Logging is really an engineering problem in the handling and transportation of materials and is becoming more clearly recognized as such with the development of better methods.

The amount of money involved in a woods operation may easily total as much as that necessary for the mill operation and due to the unavoidably rough and ready character of woods work the chances for loss are much greater.

In the ordinary northern logging job, camps for the accommodation of men and roads for the transportation of supplies must be established before any cutting of timber takes place. Main roads, branch roads and trails must be opened up into the timber. The felling crews work in the fall and early winter. Felled trees are trimmed clean and cut to the desired lengths ready for the skidding crews which follow with horses and drag the logs out the skidways on the main roads. Then follows the hauling season when great loads of logs are made up on large sleighs and hauled by horses or tractors to the "landing," which may be either on the banks of a stream or at a loading point on a railroad. If the logs are transported to the mill by water the "break-up" in the spring is a scene of great activity, since every advantage must be taken, particularly with small streams, to get the logs carried down with the smallest possible loss during the time of greatest volume of water. Much work must often be done during the summer previous to the drive in clearing out obstructions and in building dams for the accumulation of sufficient water to carry the logs

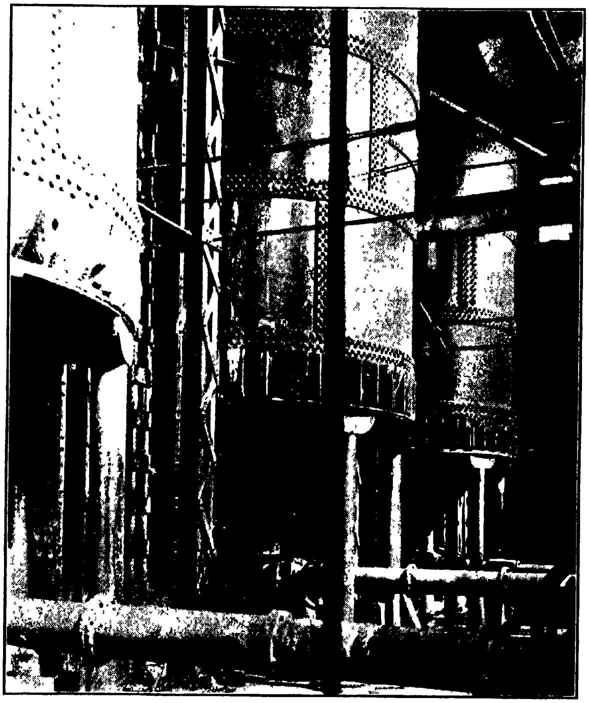


FIG. 26.—Digesters in a sulphite pulp mill.

down a stream, the ordinary flow of which would not be sufficient.

A mill which is so situated that all its logs can come by water in a single season is unusually fortunate. In many cases timber is so far distant from the mill that it takes two years to bring down a drive. This adds greatly to the expense of the undertaking, to the loss of wood through sinkage and stranding en route and to the amount of capital tied up in the operation. In a few cases it has taken as much as 3 or 4 years to get logs from the woods to the pulp mill.

Not infrequently the pulpwood is driven for a considerable distance, then taken out of the water at a cut-up plant where the logs are cut to 2- or 4-ft. lengths and the wood is then transported by barge, boat or rail to the pulp mill. The bark may be removed at such plants by rossing machines or tumbling barrels to avoid the transportation of waste material. In some cases pulpwood is cut to short lengths by means of portable saws set up in the woods and the bolts driven successfully down streams so small that logs of ordinary length could not be driven at all.

River driving has practically ceased in the Lake States, because most of the timber near drivable streams has been cut off and also because "railroad logging" has won increasing favor as a prompt and reliable means of getting the wood regularly to the mills without the uncertainties and losses which are unavoidable in river transportation. A great deal of driving is yet done in the Northeastern States and in Eastern Canada, but even here some notable developments in rail transportation of timber are taking place. As an example of changing methods, it may be mentioned that the recently constructed logging railroad of a well-known company in Ontario brought 17,000 cords of pulpwood to the mill in the month of March, 1923. Railroad logging makes it possible to take all kinds of timber to the mill with equal facility, whereas the hardwoods can be driven only for short distances and even then special precautions are necessary. Sinkage is a considerable item in the case of extended drives, even with the lighter softwoods, while logs are often left stranded along river banks despite the watchfulness of "picking-up" crews. Where it is feasible to transport timber by tractor, motor truck or rail to the mill, full utilization of the forest becomes possible.

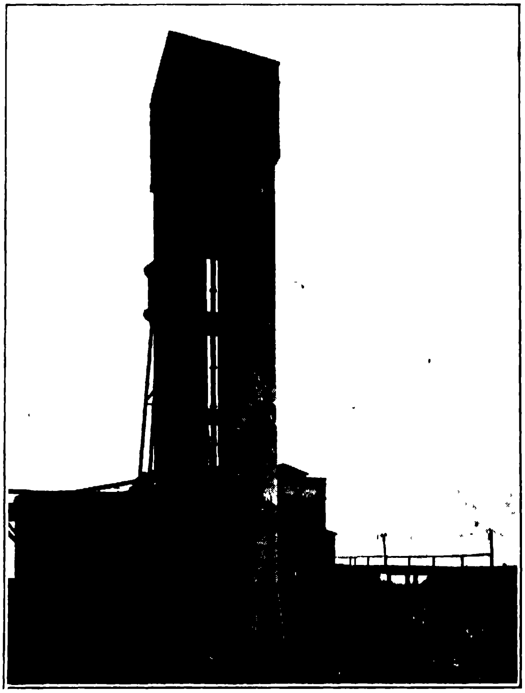


FIG. 27.—Acid making towers at a sulphite pulp mill.

A great deal of wood in the East comes from the small holdings of farmers and settlers who find the making of pulpwood a profitable winter operation when farming operations are suspended. Much of this wood is peeled in the spring by hand by the producers and is picked up by regular buyers who ship it by rail to their customers.

In the Pacific Coast States and British Columbia where large timber is the rule, a pulpwood operation is the same as a lumber operation so far as logging is concerned and a sawmill is often a feature of pulp and paper mill installations, so that as the logs come to the mill they may be turned into whichever product they are best suited for. Railroad logging takes place on a large scale in the West. In the Coast regions where rail transportation is impossible, logs are made up into rafts and towed by tugs for long distances from the point of origin to the mill. Pulpwood rafts have also been common on Lake Superior for many years. In fact, rafting where conditions permit is probably as old a method of timber transportation as river driving.

In large operations and especially those dependent upon seasonal transportation of wood by water, as much as 100,000 cords of pulpwood may be accumulated in the "block pile" at a single plant. Since the cost of such wood may run from $12 to $20 or more per cord according to kind, condition and location, it can be easily seen what a large amount of working capital may be called for. A plant may sometimes find itself with more than a year's supply of wood on hand. Great precautions are taken to protect such piles from fire and a continuous water spray is used by some companies during the danger season. One type of this system is shown in Fig. 64.

Where it has been found practicable to substitute rail for river transportation, only a comparatively small supply of wood needs to be maintained at the plant as a reserve against emergencies, and the seasonal fluctuations are done away with to great advantage. This condition is especially true in the Southern States where operations can proceed on essentially the same basis the year round.

CHAPTER V

THE UNIT OF MEASUREMENT

There is probably a greater lack of accuracy and uniformity in the measurement of wood than in that of any other basic raw material used by the great industries of the world. This has naturally arisen from the fact that as originally instituted, and still largely carried on, woods operations must be of a rough and ready character adapted to every climatic vicissitude and every obstacle offered by hill and hollow, mountain and swamp, rocky ridge and rushing stream.

Logging operations for lumber manufacture were developed and held sway in the forests long before it was dreamed that some day paper would be made chiefly from wood. When the papermakers finally turned to the forests for their raw material, it was natural that old methods of woods operations should be continued, even though some of them might better have been changed to meet the new conditions of forest utilization. In fact, it is not at all unusual to have a sawmill and a pulp mill located together under the same ownership and drawing their logs and pulp wood from the same working unit in the forest. Many times this is the arrangement which makes possible the fullest use of all species and sizes of timber growing in the forest and enables both saw and pulp mill to operate more cheaply and efficiently.

It is not strange, therefore, that methods of log measurement, devised for sawmill purposes and without thought of anything else, should be carried into pulpwood operations.

Log Scales.—The woods are literally full of "log scales," *i.e.*, rules and sets of tables which purport to indicate the number of feet of lumber that may be sawn from logs of different lengths and diameters. All such rules in common use are of more or less arbitrary character and the product may vary 10 to 100 per cent from the amount indicated by the log scale, depending upon size of timber, thickness of saws, kind of product and other factors. Different rules are recognized, in some cases legally, in various states and localities and since those who use these rules are generally conversant with their discrepancies, allowances for "over-run" or "under-run" are made in calculating the actual lumber cut to be expected from the scale of any particular lot of logs.

FIG. 28.—The beater room in a paper mill.

One widely known rule, and most easy to remember because of its simplicity, is the Doyle rule which is stated mathematically as $\left(\frac{D-4}{4}\right)^2 L$, in which D is the diameter of the log in inches at the small end inside the bark and L the length in feet. For example, a sound, straight log, 16 ft.

long and 16 in. in diameter, measured in this fashion, would scale 144 bd. ft. When sawed into lumber, the actual cut from this log might be materially different as previously suggested. The Doyle rule falls far below the actual contents in small logs and is too high for very large logs.

The Scribner rule is another widely known rule and a variation from it in which fractions are disregarded and the measurement given in the nearest multiple of 10 bd. ft. is the standard of the United States Forest Service known as the "Decimal C" rule.

In the Adirondacks, the "standard" is an old-time unit of measurement, a "standard" being the equivalent of a log 13 ft. long and 19 in. in diameter at the small end. Such a log scales 195 bd. ft. by the Scribner rule. The Holland rule has long been used in Maine and the Blodgett rule in New Hampshire.

The New Brunswick rule is legal in that province and the Quebec rule in the province of Quebec, the latter being not far from the Scribner rule.

What Is a Cord?—When not scaled by log rules, pulpwood is usually measured in "cords," a cord being the amount of wood that can be stacked in a space 8 ft. long, 4 ft. wide and 4 ft. high, or the equivalent of 128 cu. ft. of space. Probably the pulp mills first adopted the cord as a unit of measurement for their raw material because the wood that they originally used was in short lengths and the cord was an accepted and generally understood unit for firewood. There is certainly no reason why the cord any more than a thousand board feet should be the unit for pulpwood measurement and neither is adapted to the real needs of the processes and the product involved.

But a cord never contains 128 cu. ft. of solid wood, because round pegs do not fit square holes. Wood is never symmetrical in form, and there is great variation in content depending upon size. In actual practice, therefore, a "cord" of wood may contain as little as 70 cu. ft. or as much as 100 cu. ft. of solid wood. An actual content of

90 cu. ft. of solid wood per commercial cord is probably not far out of the way in the average case.

It should be noted here that the French cord in Quebec is 8 ft. 6 in. by 4 ft. by 4 ft. 3 in., with a total volume of 144 cu. ft., and occasionally other local variations are met. However, in ordinary parlance, a cord means the equivalent of a volume of 128 cu. ft.

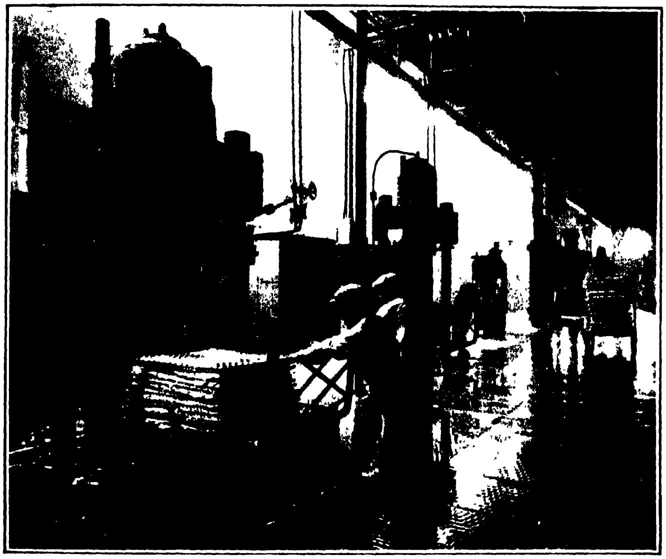


Fig. 29.—Hydraulic pulp presses capable of exerting a total pressure of 600 tons.

There are other complications. A cord of wood may be rough, peeled or rossed, with corresponding variations in actual volume. A cord of wood with the bark on may shrink in volume as much as 15 per cent when peeled by hand or drum barked and as much as 25 per cent when rossed, as the knives which remove the bark also cut away some wood no matter how carefully the rossing operation is carried on.

Conversely, a cord of peeled wood contains more wood than a cord of rough wood and a cord of rossed wood more wood fiber than a cord of peeled wood because wood thus prepared stacks more closely. Such differences in the condition of wood account to quite an extent for the variation in reports as to the yield of pulp per cord of wood by various processes. No real comparisons can be made unless the same kind of a "cord" is dealt with.

Of the 6,114,072 cords of wood used by the pulp and paper mills in the United States in 1920, rough wood amounted to 2,875,860 cords, peeled wood to 2,891,221 cords and rossed wood to 346,991 cords. A very large proportion of the pulpwood brought into the United States from Canada is peeled or rossed, since it does not pay to have freight charges for long distances on worthless bark.

Conversion Factors.—But there is still another confusion in pulpwood measurements. In many instances pulpwood is cut and transported to the mill by water or rail in the form of logs (sometimes tree-length) and in the woods operations is scaled in thousand board feet by one of the numerous log rules. Then for mill operations the log scale is converted into cords, the conversion factor varying according to locality, character of timber and scale used. In the East, 1,000 ft. log scale is generally assumed to be equivalent to two cords of wood or 500 bd. ft. per cord. In some places, however, a cord is assumed to equal 550 or 600 bd. ft., while on the Pacific Coast, a converting factor or 700 or 750 bd. ft. per cord is used in some cases. In Quebec the legal equivalents are 600 bd. ft. for a cord of rough wood and 700 bd. ft. for a cord of rossed wood.

Better Methods.—As noted previously, there is nothing in the pulp making processes that in any way renders the cord, board foot or any other volume measurement the most suitable unit for raw material. It is wholly a question of expediency, influenced by methods inherited from other days and other types of wood utilization.

Some paper mill managements have adopted 100 solid cu. ft. of pulpwood as their working unit, and this is a great improvement over the haphazard cord where accurate scaling can be enforced. Perhaps the best that can be hoped for in this direction is the development of an automatic scaling device which will continuously record the volume of pulpwood as it passes along a conveyor on the way to grinder or chipper.

But the fundamental difficulty is that except for wood, all material that enters into paper making is measured by weight instead of volume and this is true also of the finished product. Obviously there can be no accurate checking of product against raw material and consequent complete determination of conversion losses when the material is measured by volume and the product by weight.

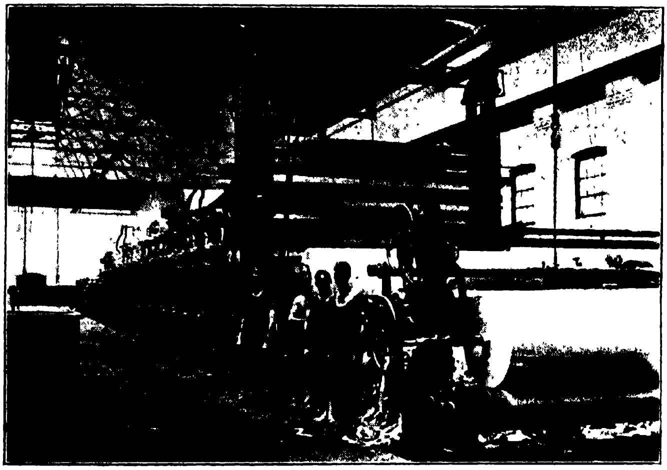


FIG 30.—A modern high speed paper machine.

The theoretically correct method is to weigh all wood into the mill with sufficient sampling to determine the percentage of moisture it contains. Only in this way is it possible to know exactly how much wood fiber there is to start with and to check against it the amount that comes out in the form of pulp or paper. A few manufacturers of chemical pulp are already doing this through the use of a device which automatically weighs and records the weight of the chips of wood as they are carried on a belt conveyor. Samples of the chips are frequently tested for moisture, and in this way the amount of wood fiber used is accurately and constantly known.

It is not so simple a matter to weigh and test wood which comes to a groundwood mill by water or rail, but the difficulties are not insuperable and good experimental results have already been obtained. It is likely that before long we shall hear of the regular employment of methods of wood measurement that are a great improvement over present practice.

21 JUL 1924

CHAPTER VI

PULPWOOD GRADES

In some localities logs intended for lumber have long been definitely graded according to size and quality but no general standards have as yet been set up for pulpwood.

An essential step in the utilization of material which is not uniform in character is the separation into grades within the limits of which there is sufficient uniformity to permit of like treatment and the establishment of proper values.

The chief defects in pulpwood are knots and decay, since the fibers are too short in knots even if they can be reduced to pulp, which is not usually the case, while in advanced stages of decay, the fibers are completely destroyed.

The extent to which wood in the less advanced stages of decay can be used for pulp is a matter of current investigation.

It is interesting to note that the following suggested grades for 4-ft. peeled pulpwood are under discussion among operators in the State of New York:

No. 1.—Minimum diameter, 5 in.
    Maximum knot, 2 in.
    No decay allowed.
    Wood to be not less than 80 per cent spruce, balance balsam.

No. 2.—Minimum diameter, 4 in.
    Maximum knot, 3 in.
    Not over 5 per cent decay allowed and no single stick to be more than 25 per cent decayed.
    Wood to be not less than 60 per cent spruce, balance balsam.

No. 3.—Minimum diameter, 3 in.
    Maximum knot, 4 in.

Not over 10 per cent decay allowed and no single stick to be more than 25 per cent decayed.

Wood to be not less than 40 per cent spruce, balance balsam.

While these rules may never be adopted and enforced, their formulation indicates something of the problem that confronts the pulp mill operator who wants the best possible material for his plant and the problem faced by the timberland owner who wishes to dispose of every possible stick of timber. Nature produces more imperfect trees than perfect ones, and the segregation of the logs cut in the forest into classes based on common defects is a helpful step in their utilization. More will be heard of such matters as wood becomes more valuable.

CHAPTER VII

PULPWOOD USED IN NORTH AMERICA

Quantities.—*United States.*—Based upon reports as to wood pulp produced, the earliest fairly authentic estimate for the quantity of pulpwood used in the United States is 2,200 cords in the year 1870. In similar fashion there is an assumption of 41,000 cords of wood manufactured into pulp in the United States in 1880 and 583,200 cords reported 10 years later.

By 1890 the manufacture of wood pulp in the United States had become an important industry, while during the succeeding 9 years the quantity of wood used increased 240 per cent, making a total for the census year 1899 of 1,986,000 cords.

The year 1899 also marks an especially important point in the American paper industry, because it is the first year for which there are official figures upon the use of imported wood to manufacture paper in the United States. As a matter of fact, this must have been going on for a number of years previous to that date, since the Census reports for 1899 show that of the nearly 2,000,000 cords of wood used to make paper pulp in the United States mills, 369,000 cords or 18 per cent of the total was imported. In the succeeding 23 years with an increasing consumption of pulpwood, imports have also increased and it is an interesting coincidence that for this entire period an average of 18 per cent of imported wood has been used and 82 per cent of domestic wood, the amount of imported wood used in any one of these years being not less than 14 per cent as in 1918 nor more than 23 per cent as in 1910.

Rapid as was the increase in the use of pulpwood in

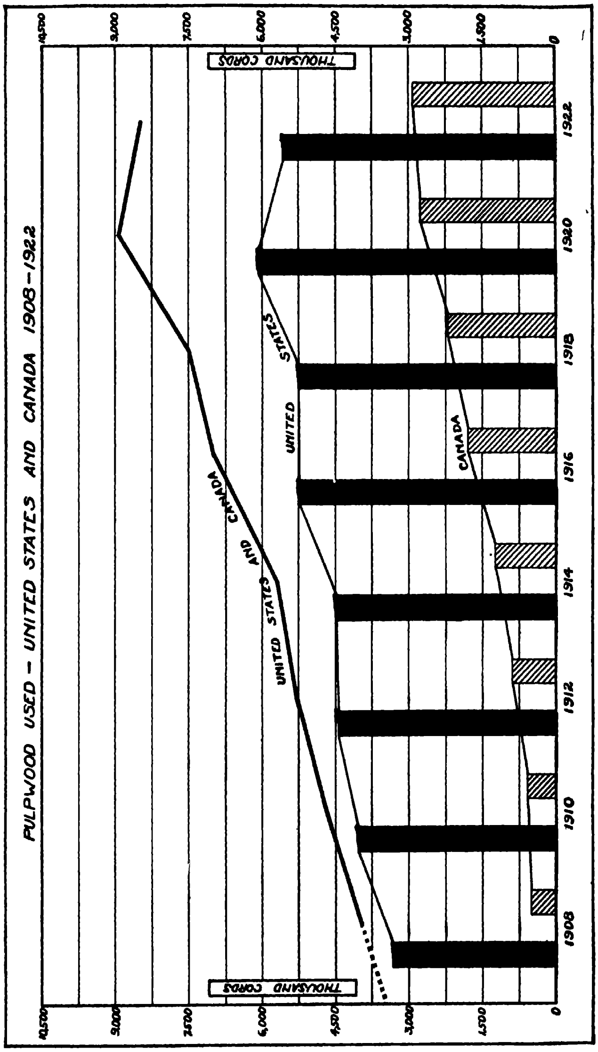


FIG. 31.—Pulpwood used—United States and Canada, 1908–1922.

the United States during the decade starting with 1890, the development of the industry went ahead vigorously in the second 10-year period. Consumption again doubled bringing the total in 1909 to an even 4,000,000 cords, of which a little more than 3,200,000 cords was domestic wood and nearly 800,000 cords imported. In the following 10 years the increase in pulpwood consumption was 37 per cent making a round total in 1919 of 5,478,000 cords of which 1,032,000 cords was imported wood—the first time we have reports of more than a million cords of Canadian wood being used in United States mills in a single year.

The highest figure of pulpwood consumption in the United States so far reached was 6,114,000 cords in 1920 of which practically 1,100,000 cords was imported. This was followed, however, due to well-known causes, by a decrease of 25 per cent to 4,557,000 cords in 1921 with a come-back in 1922 of 22 per cent to a total of 5,549,000 cords.

Canada.—Unfortunately, there is not even a basis for a good guess as to the quantity of pulpwood either produced or used in Canada prior to 1908. For that year, however, there are reports which show a production of 1,325,000 cords of which 842,000 cords or 64 per cent was exported and 483,000 cords or 36 per cent was used in Canadian mills. In the United States there has been a steadily increasing consumption of pulpwood with rather constant percentage distribution between domestic and imported wood. In Canada the situation has been reversed with increasing production and consumption of pulpwood, but very little increase in total quantity exported for the last ten years due to a considerable extent to the efforts made to bring about a greater development of manufacturing processes in Canada instead of the exporting of raw materials.

While the production of pulpwood in Canada which totalled 1,378,000 cords in 1908 had more than doubled by 1916 and reached 4,025,000 cords in 1920, the exports of

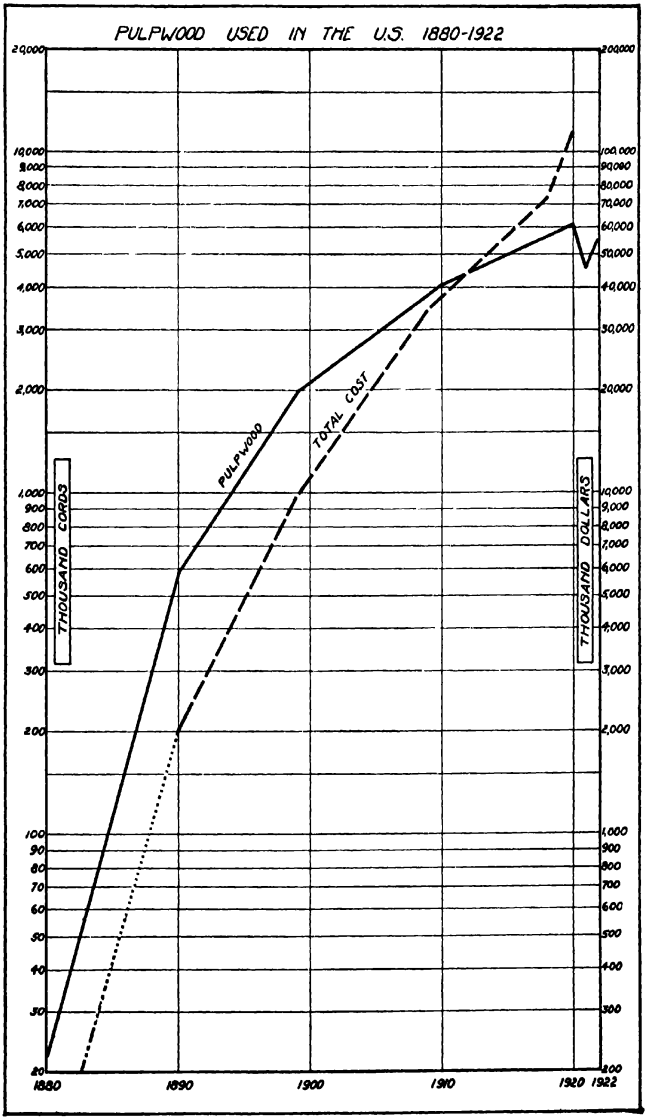


Fig. 32.—Pulpwood used in the United States, 1880–1922.

pulpwood apparently reached their peak with 1,350,000 cords in 1918 and have not since come up to that figure. On the other hand, while the Canadian mills used 483,000 cords in 1908 the consumption had considerably more than doubled by 1913 and doubled again by 1918, reaching a temporary maximum in 1920 of 2,777,000 cords. However, this figure was surpassed in the year 1922 with a domestic consumption of 2,913,000 cords.

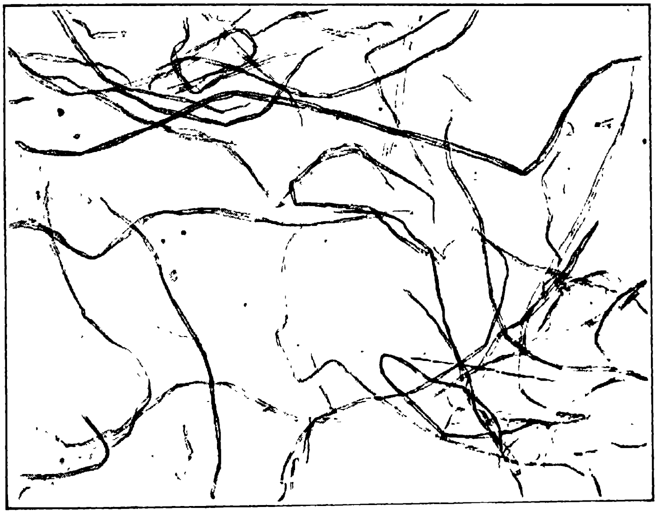


Fig. 33.—Sulphate pulp. Spruce fibers greatly magnified.

We thus find that while in 1908, 65 per cent of the pulpwood cut in Canada was exported and only 35 per cent used in Canadian mills, that by 1920 only 31 per cent of the greatly increased cut was exported and 69 per cent was made into pulp or paper in Canada before it was marketed.

The development of the pulp industry in Canada was greatly stimulated by the action of several provinces in 1910 in prohibiting the further exports of unmanufactured wood from Crown lands. In 1913 Congress removed the duty upon news print paper imported into the United

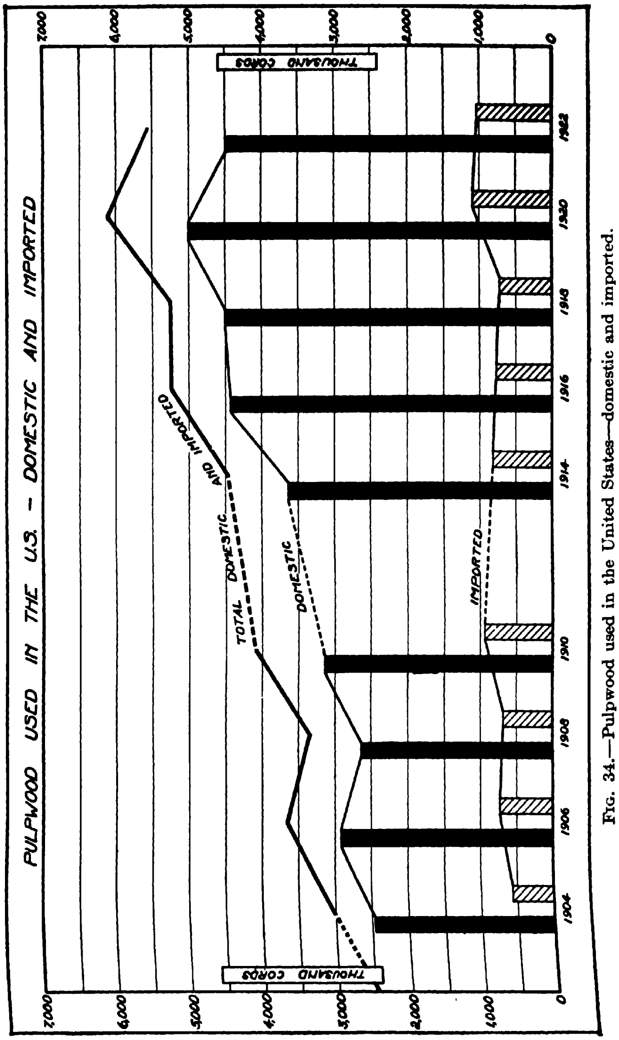


Fig. 34.—Pulpwood used in the United States—domestic and imported.

States and this gave added impetus to the manufacture of pulp and paper in the Dominion.

Detailed figures upon the production, consumption and exportation of pulpwood in the various Canadian Provinces are available only since 1910. For the 11 years from 1910 to 1921, inclusive, there was a cut of 18,760,000 cords in Quebec of which 53 per cent was used in Quebec mills and 47 per cent exported; a production of 8,300,000 cords in Ontario of which 78 per cent was used at home and only 22 per cent exported; a cut of 2,980,000 cords in New Brunswick of which 64 per cent was exported, and of 336,000 cords in Nova Scotia of which 28 per cent was shipped outside the Province. Only a fraction of the 1,539,000 cords of pulpwood cut in British Columbia from 1910 to 1921 was exported. Summing up these 11 years we find a cut of 31,917,000 cords of pulpwood in these five Provinces of which 19,343,000 cords or 61 per cent was consumed at home and 12,574,000 cords or 39 per cent exported.

Prior to 1908 and running back to 1890 there are figures upon the value of the pulpwood exported from Canada, although information upon quantities is lacking. In 1890, for example, it is reported that pulpwood valued at $22,808 was exported from Canada to Great Britain and to a value of $57,197 to the United States, making a total value of $80,005. By 1900 exports of pulpwood to the United States had increased in value to $864,000 out of a total of $903,000 with a value of $38,000 going to Great Britain. In 1902 wood to the value of $120,000 went to Great Britain, but 91 per cent of the total value of $1,315,000 went to the United States and there are no reports of exports of pulpwood to Great Britain since that time.

For the 19 years of 1890 to 1908 pulpwood to the value of $23,694,500 was exported from Canada of which 98 per cent went to the United States and practically all the rest to Great Britain. Carrying the computations down to present time we find that pulpwood to a total value of

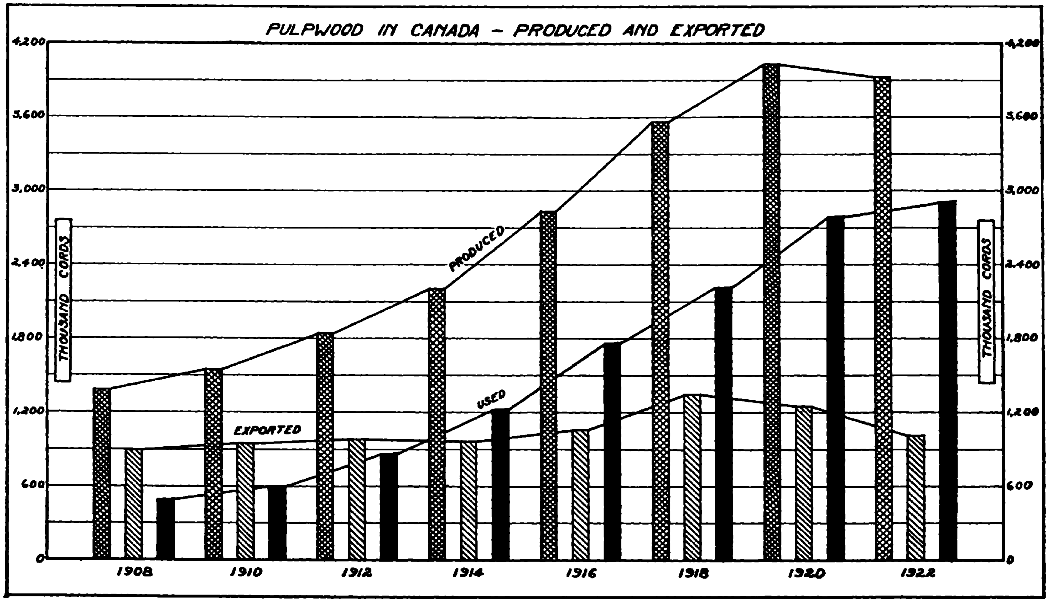


FIG. 35.—Pulpwood in Canada—produced and exported.

$153,451,777 has been exported from Canada—an item of no small consequence in the development of the country.

Comparative Consumption.—Combining available data upon the consumption of pulpwood in the United States and Canada we find in round numbers the use of 3,830,000 cords in 1908, which increased 95 per cent to 7,462,000 cords in the next 10 years and reached a peak of 8,890,000 cords in 1920. In 1922 the total was about 8,460,000 cords.

Fig. 36.—A kraft mill in Louisiana.

These sound like large figures and they are large figures in themselves, but nevertheless, very small compared with the total use of wood in North America. It is a frequent custom among the uninformed, and sometimes among those who should know better, greatly to exaggerate the relative importance of the amount of wood used to make paper in North America. As a matter of fact, over a period of years the total amount of wood used for paper-making in the United States and Canada combined does not average more than 8 per cent of the quantity of wood used for the

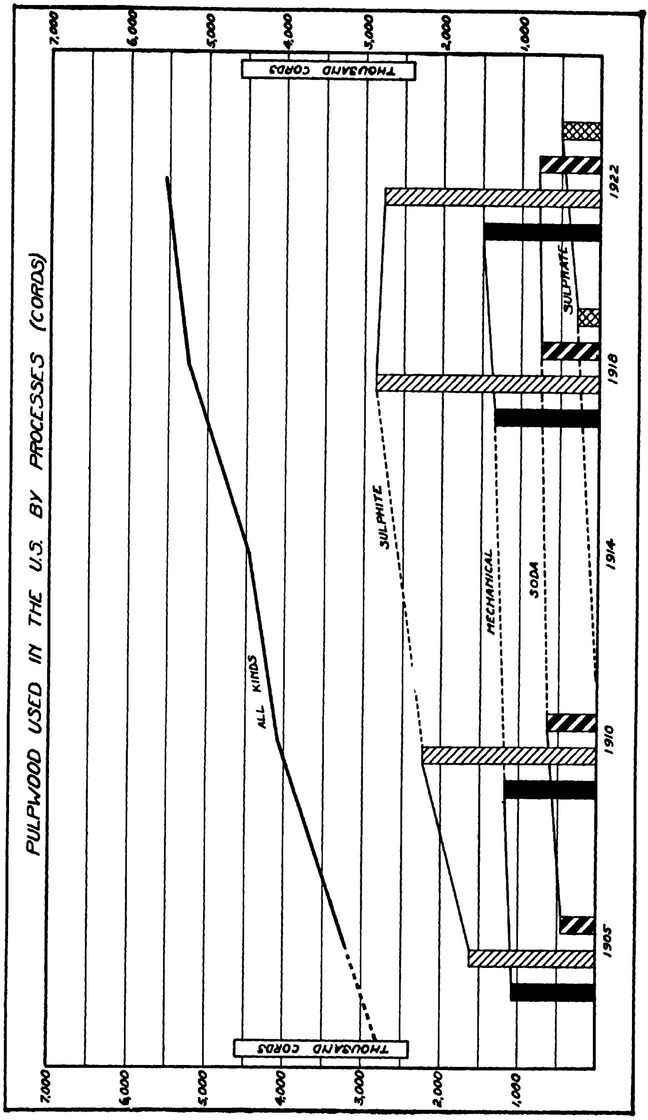


FIG. 37.—Pulpwood used in the United States by processes, 1908–1922.

manufacture of lumber in these countries and to a much smaller percentage of the total quantity of wood used for all purposes, if we include such items as railroad ties, telegraph and telephone poles, cooperage, veneer stock and firewood. Because the use of pulpwood has been concentrated into a few well-known regions and local areas and upon three or four species of timber its relative importance compared with the total demands upon the forest resources of North America has been misunderstood.

From the beginning of the wood pulp industry in North America to the present time, some 100,000,000 cords of pulpwood has been used in the United States of which 18 million cords came from Canada. There has also been a consumption of about 30,000,000 cords of pulpwood in Canada, or a total of 130,000,000 cords for the two countries combined. There is no question but 130,000,000 cords is a lot of pulpwood, but until recent years, the annual consumption of firewood alone in the United States was estimated at 100,000,000 cords, or as much wood as has gone into paper in this country in the past 50 years. The annual consumption of wood for fuel in Canada is estimated at twice the quantity used for pulp. Firewood is cut in small quantities over great areas and from many kinds of timber, much of which is not fit for other uses. Pulpwood is cut in large quantities of few species over comparatively small areas, hence the attention that has been drawn to it.

There is no desire on the part of the author in any way to minimize the necessity for vigorous and adequate measures to maintain the timber supply of the country if the future needs of the people are to be met, but it is never wise in any discussion unduly to emphasize some factors and wholly to overlook others. This sometimes has been the case with the writers who are not fully conversant with the varied phases of forest utilization in North America.

Processes.—*United States.*—In the United States the sulphite process has always been the largest consumer of

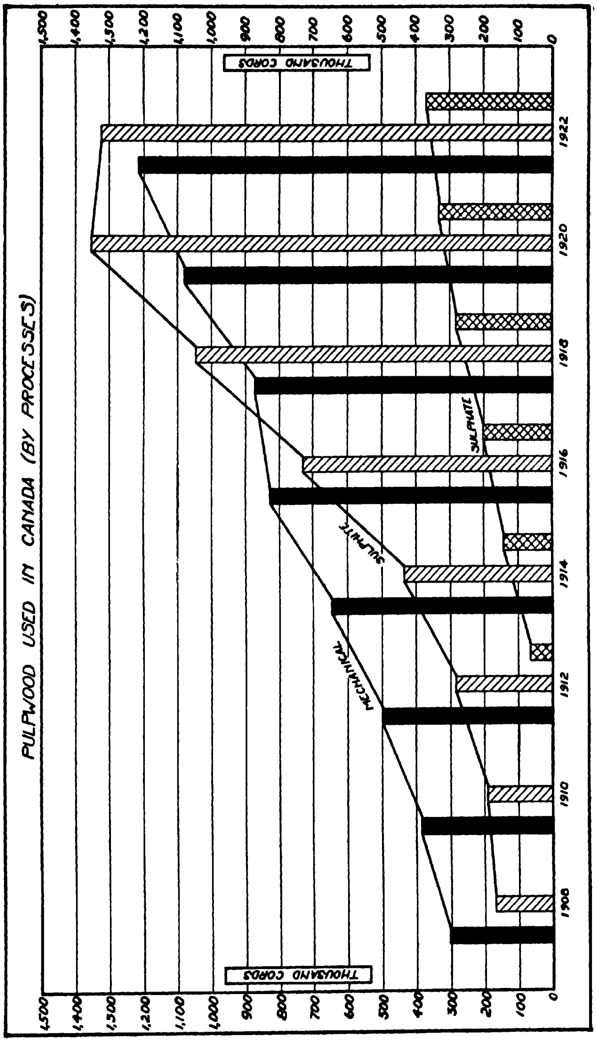


FIG. 38.—Pulpwood used in Canada by processes, 1908–1922.

wood among the various methods of transforming that highly useful material into paper, and since pulpwood has been used in the United States it is safe to say that not less than half of the total quantity has been taken by the sulphite process.

The earliest separate figures upon the quantity of wood used for the various processes in the United States are for the year 1905 when the sulphite process took 1,630,000 cords, the mechanical process 1,097,000 cords and the soda process 465,000 cords out of a total of 3,192,000 cords reported. In 1907 more than 2,059,000 cords of pulpwood went into paper via the sulphite process, 1,361,000 cords were made into mechanical pulp and 542,000 cords into soda pulp. There was a falling off of more than 600,000 cords in pulpwood consumption in 1908, due to business depression, about proportionately distributed between the three processes. In 1918 with almost exactly the same quantity of wood used for mechanical pulp as in 1907, the sulphite process had grown to a consumption of 2,860,000 cords, the soda to 749,000 cords and the recently introduced sulphate process to nearly 300,000 cords.

In the peak year of 1920 the sulphite mills in the United States used 3,200,000 cords of pulpwood, the groundwood mills 1,591,000 cords, the soda mills 924,000 cords and the sulphate mills almost 400,000 cords making a total of 6,114,000 cords and a figure which is not likely to be greatly surpassed for some time to come.

Since the establishment of the wood pulp industry in the United States, it appears that 50 per cent of the total quantity of wood used has gone into the sulphite process, 32 per cent into the mechanical process, 15 per cent into the soda process and 3 per cent into the sulphate process.

Canada.—While the sulphite process always has been by far the largest user of pulpwood in the United States, we find the reverse case in Canada where prior to 1918 the mechanical process was the largest single factor in the use of pulpwood. Since that date honors have been about even between the two processes in point of wood consumption.

Credited in round numbers with 307,000 cords in 1908, the mechanical process in Canada steadily developed to a consumption of more than 1,000,000 cords in 1919 and the average since then has been in excess of that figure. The sulphite process took 171,000 cords in 1908 and rose to more than 1,000,000 cords in 1918—an increase of nearly 500 per cent in 10 years. A peak of 1,345,000 cords was reached in 1920, the year of extraordinary demand for sulphite pulp, which temporarily dropped off to 982,000 cords in 1921.

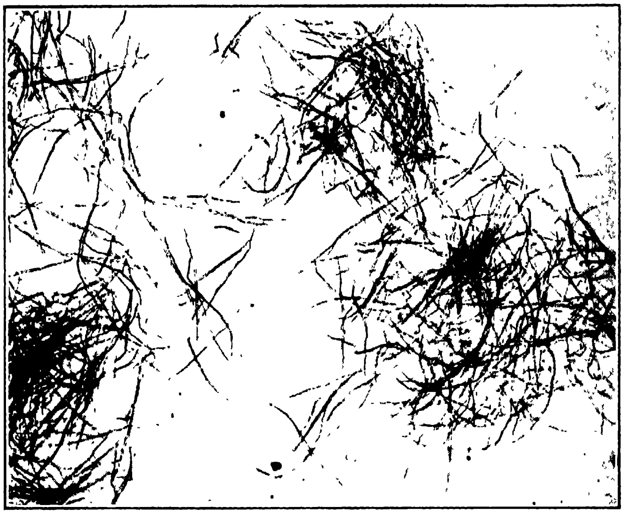


Fig. 39.—Soda pulp. Red maple fibers greatly magnified.

The sulphate process is a newcomer which first attained separate recognition in the Canadian reports with nearly 67,000 cords of pulpwood used in 1912, although unquestionably the totals credited to the soda process for the three preceding years consisted largely of wood which really went into the sulphate process.

The use of wood in the sulphate process in Canada doubled in 1913 over 1912 and doubled again in 1917 over 1913 rising to a little more than 330,000 cords in 1920 from which as in other branches of the industry there was a temporary slump in 1921.

From 1908 to the present time the statistics indicate that out of a total consumption of some 23,000,000 cords of pulpwood in Canada 47 per cent has gone into the mechanical process, 41 per cent into the sulphite process and 11 per cent into the sulphate process. The soda process accounts for the remaining fraction but it has never attained any appreciable size in the Dominion.

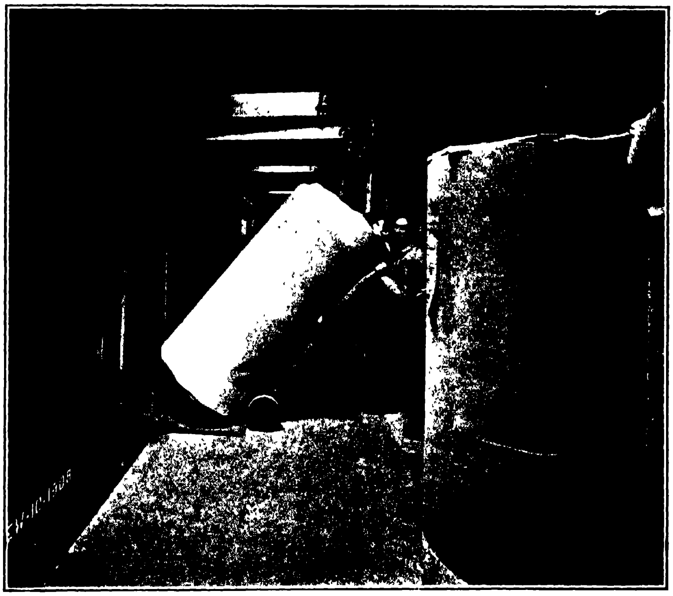


FIG. 40.—Loading a 1200-lb. roll of finished paper.

Regions.—*United States.*—Since the earliest days of paper-making in America, New England has been prominently associated with the development of the industry and the largest consumer of materials. In 1904, for example, the pulp mills in New England took 36 per cent of the more than 3,000,000 cords of pulpwood then used in the United States. While during the past 20 years there has been some shifting of the industry to newer fields and an increase of nearly 100 per cent in its requirements for raw materials, New England has used increasing quantities of wood and has maintained nearly the same relative predominance with respect to total consumption. It is noteworthy that in 1920 the pulp mills in New England consumed 32 per cent of all the pulpwood used in the United States and that the 1,966,000 cords which went into some kind of paper in that region in 1920 represented an increase of 81 per cent or nearly 900,000 cords over the quantity used in 1904.

Next to the group of New England States, New York ranks second and for many years has been first as a single state in the paper industry. In 1904 some 864,000 cords of pulpwood were used in New York mills or 28 per cent of the total consumption at that time. The million cord mark was substantially passed by 1916, and in 1920 the total for the New York mills was 1,130,000 cords or 19 per cent of the 6,114,000 cords of wood used for paper pulp in the United States. While the total amount of wood used in New York has increased somewhat during the past 20 years the increase has not been so large as in some other regions, because of the greater dependence of the New York mills upon outside sources for pulpwood.

The industry in Pennsylvania has run along on remarkably even keel and the 490,000 cords of wood used in 1920 was 8 per cent of the total consumption of pulpwood in the United States in that year, as was the 243,000 cords used 16 years earlier. While the industry has never been nearly so large in Pennsylvania as in some other states it has been able through the importation of pulpwood from both Canada and the more southern states to maintain its relative importance compared with the rest of the country.

During the past 20 years one of the most notable features of the paper industry has been the increased production in the Lake States. Consequently, we find that while Michigan, Wisconsin and Minnesota mills used slightly less than half a million cords of pulpwood in 1904, or 16 per cent of the total, the million cord mark was much exceeded before 1916 and that in 1920 the Lake States mills in round numbers took 1,463,000 cords or 24 per cent of the total consumption at that time.

The growth of the industry in the Lake States has been much accelerated through the utilization of hemlock in the sulphite process and, more recently, the application of the sulphate process to several of the native woods while at the same time importations of pulpwood have been an important source of raw material.

The newest regions of paper-making in the United States are the Southern States and the Pacific Coast. In 1904 only 57,000 cords of pulpwood went into the Pacific Coast mills. By 1909 the quantity had doubled and it more than doubled again in 1916. In 1920 the Pacific Coast mills used 334,000 cords of pulpwood, or 5 per cent of the total consumption of that year, the principal species being native spruce and hemlock, both of which are excellent paper-making materials.

Earlier data upon the wood used in the pulp mills of the Southern States are lacking, but in 1920 the reports indicate a consumption of practically 167,000 cords each in the mills of both North Carolina and Virginia, the Virginia mills using chiefly spruce, yellow poplar, yellow pine and hemlock, while the North Carolina mills used hemlock, yellow pine, some spruce and a considerable variety of hardwoods.

There is also a considerable consumption of pulpwood, chiefly Southern yellow pine, in a number of other Southern States and the adaptability of these pines to the sulphate process suggests considerable further development in that region.

Summing up the quantity of pulpwood that has gone

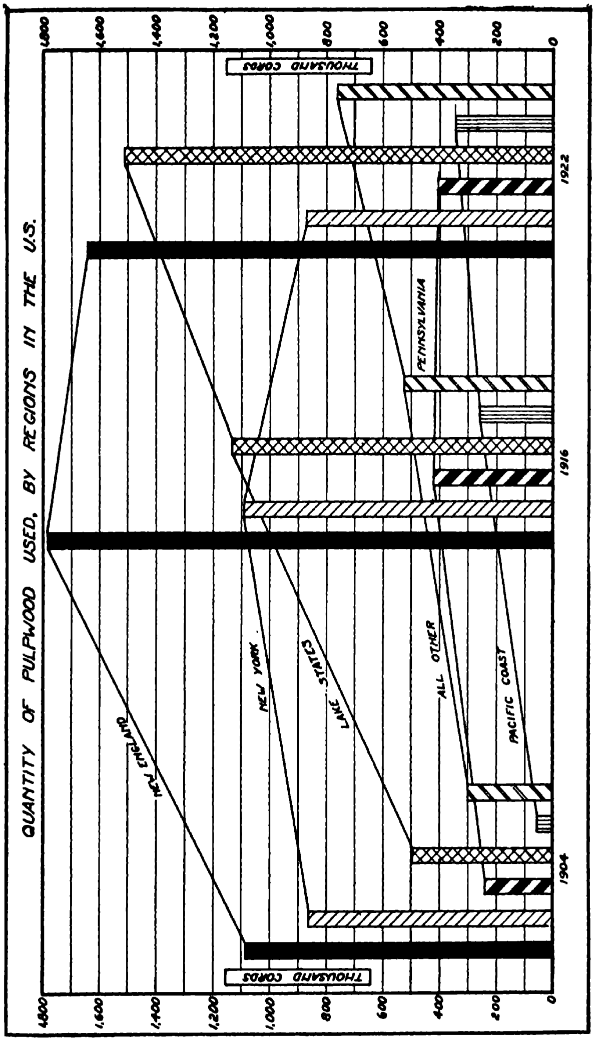


FIG. 41.—Pulpwood used in the United States, by regions, 1904–1922.

into the mills in the United States since 1904 as best we can from available data we get the following table:

PULPWOOD USED BY REGIONS, UNITED STATES, 1904-1922

	Cords	Per cent
New England.	27,740,000	34
New York...	17,880,000	22
Lake States	17,100,000	21
Pennsylvania	6,420,000	8
Pacific Coast	3,260,000	4
Other......	9,600,000	11
Total	82,000,000	100

It should be noted in this connection that the total quantity of pulpwood used in the United States since the establishment of the industry exceeds 100,000,000 cords, but it is only for the past 18 years that regional figures have been compiled.

Canada.—Beginning, as we must, with 1908 because of the lack of earlier statistics, we find in that year a total consumption of 483,000 cords of pulpwood in Canada of which the mills in Quebec took 256,000 cords or 53 per cent, and those in Ontario 155,000 cords or 32 per cent, while the New Brunswick and Nova Scotia mills used only 54,000 cords and 18,000 cords respectively. In succeeding years the relative magnitude of the mills in the provinces of Quebec and Ontario was well maintained with the Quebec mills in 1920 taking 1,334,000 cords and the Ontario mills 943,000 cords out of a total consumption in the Dominion of 2,777,000 cords in that year.

By 1920 the requirements of the New Brunswick mills had increased more than three times from 1908 with a total of 180,000 cords. But little change has taken place in the Nova Scotia mills from 1908 to the present time and they are using no greater volume of pulpwood today than they did a dozen years ago. On the other hand, coming into the picture for the first time with 1,316 cords of pulpwood used in 1909, the British Columbia mills took a quarter of a million cords just 9 years later and almost 300,000 cords in 1920. The species used in British Columbia, as on the Pacific Coast of the United States, are chiefly Western hemlock and sitka spruce.

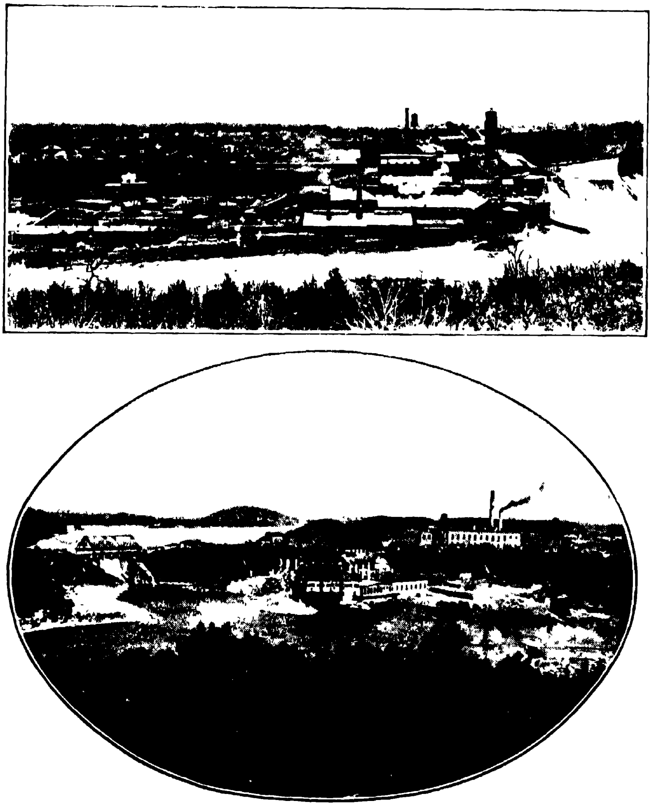


FIG. 42—Paper mills which make their own groundwood and sulphite pulp.

Totaling the consumption of pulpwood in Canada from 1908 to the present time in round numbers at 23,000,000 cords, we find that the mills of Quebec have taken 52 per cent of the entire quantity, those of Ontario 33 per cent, the New Brunswick mills 6 per cent, the mills of British Columbia 7 per cent, and the Nova Scotia mills but little more than 1 per cent.

Species.—*United States.*—Satisfactory information upon the various woods used for the manufacture of pulp in the United States is particularly lacking when we attempt to get back into the earlier developments of the industry. In 1899, for instance, the Census reports distinguish only spruce, balsam fir and poplar, the first two being totalled together. Out of the 1,986,000 cords of wood that went to the pulp mills in that year spruce and balsam are credited with 76 per cent of the total and poplar with 13 per cent, while there was 220,000 cords of miscellaneous species, for which no details are available. The same classification was maintained by the Census for the calendar year 1904 with spruce and balsam fir making up 75 per cent of the total quantity of pulpwood reported and poplar 8 per cent with 532,000 cords in the miscellaneous group, the latter item indicating very strongly the turning toward new species, the most important of which was hemlock.

First distinguished in the census reports with 375,000 cords of pulpwood in 1905, hemlock has been a steady factor in the development of the industry and increased to 885,000 cords in 1920 when in that year this species contributed 14 per cent of the total quantity of pulpwood used.

It has been noted elsewhere that poplar has been chiefly utilized in the manufacture of soda pulp and that the soda pulp industry has shown the least growth of any branch of pulp-making in the United States. The supply of poplar timber is not large and there has been no great change in the amount of poplar pulpwood used for the past 15 years. A total of 368,000 cords was attained in 1920. Such recent development as there has been in the soda industry has come about very largely through the utilization of other broad-leaved species, particularly gum,

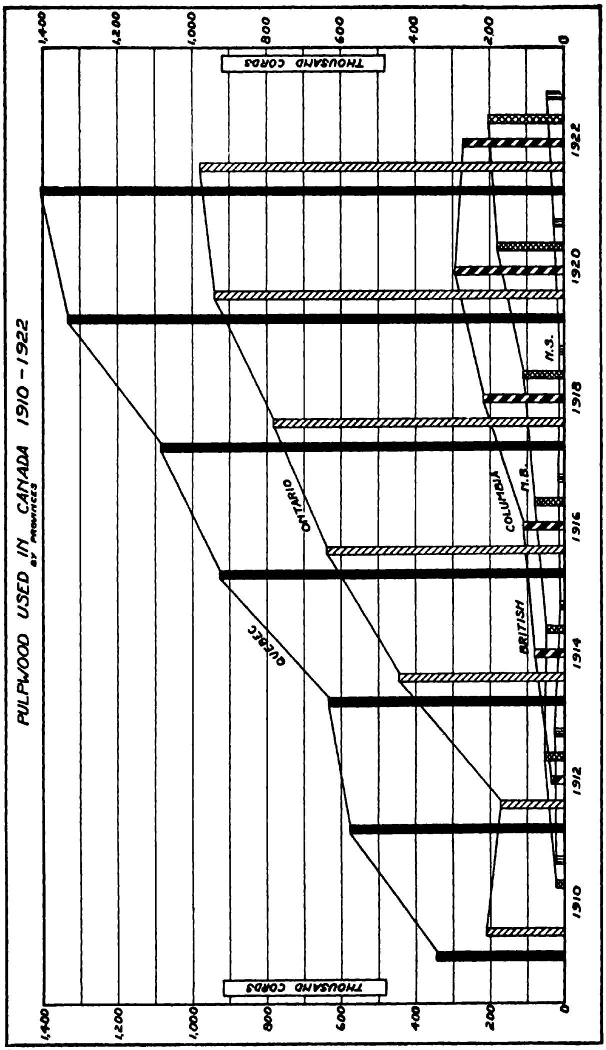


FIG. 43.—Pulpwood used in Canada, by provinces, 1910-1922.

beech, birch and maple. These woods were noted separately for the first time in the 1916 reports with a total of 115,000 cords and an increase 4 years later to more than 190,000 cords.

The use of pine for pulpwood was first noted in the census report of 1905 with a little more than 57,000 cords, the term being used to include both jack pine and Southern yellow pine. There was a moderate increase in the use of these species during the next 5 years with comparatively large quantities going into pulp at later dates, so that in 1920 Southern yellow pine and jack pine contributed 363,000 cords of pulpwood to the paper-making materials used in that year.

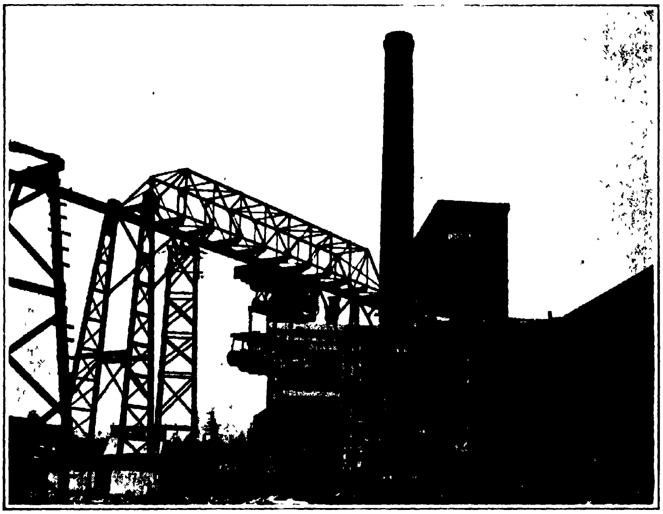


FIG. 44.—Monorail carrier used to transport rolls of paper from the finishing room to the dock. The same method is used to bring material into the mill.

Summing up the total quantity of pulpwood used in the United States from 1905 to the present time we can estimate in round numbers that during these 18 years spruce and balsam fir have furnished 65 per cent of the

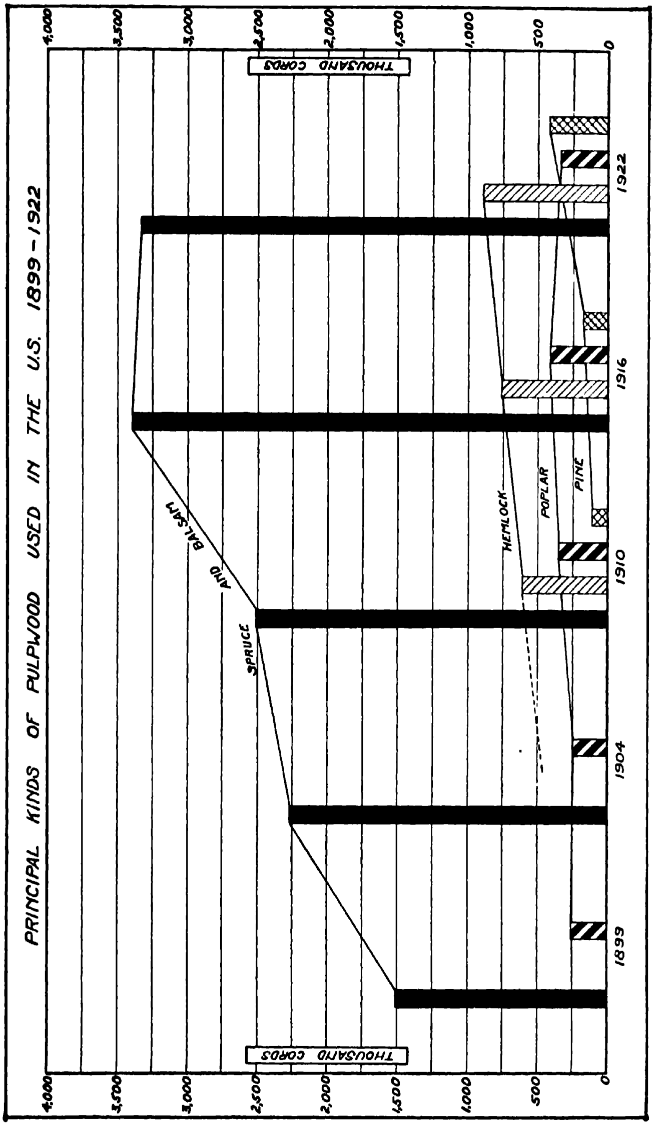


FIG. 45.—Principal kinds of pulpwood used in the United States, 1899–1922.

total quantity used, hemlock 15 per cent, poplar 8 per cent, pine 3 per cent and other woods about 9 per cent.

Canada.—The range of species available for pulpwood is less in Canada than in the United States due to the fewer kinds of timber in the more northern regions. In 1908 the Canadian reports show that of the 483,000 cords of pulpwood used, spruce furnished 421,000 cords and balsam fir 58,000 cords or practically the entire supply. In 1920 of the 2,777,000 cords of pulpwood used in the Canadian mills, spruce is credited with 1,873,000 cords and balsam fir with 688,000 cords, the two species together making up almost 93 per cent of the total.

Hemlock first appears in the Canadian reports with 700 cords in 1909, which increased to 176,000 cords in 1920, due chiefly to development of the paper industry in British Columbia. The reports upon the use of jack pine in the Canadian mills are of very irregular character, fluctuating from nothing in some years to more than 40,000 cords in 1915 and again in 1921. It is more likely that these are errors in the statistical reports than that there were such wide variations in the amount of jack pine used from year to year in the Canadian mills, although it has never been a large factor in their supply.

Very little poplar has gone into the Canadian pulp mills, because of the lack of development of soda pulp manufacture and the quantity reported has ranged from less than 2,000 cords in the year 1908 to a little under 10,000 cords in 1918 with an average under 5,000 cords per year. Summing up the reports from 1908 to the present time we find that the Canadian mills have used 73 per cent of spruce, 21 per cent of balsam fir and 4 per cent of hemlock in meeting their requirements for pulpwood on the basis of the industry as developed during this period.

Costs.—*United States.*—As is only too well known throughout the industry and to some extent by the general public, the paper manufacturers of North America have had to meet a steadily increasing cost of raw materials

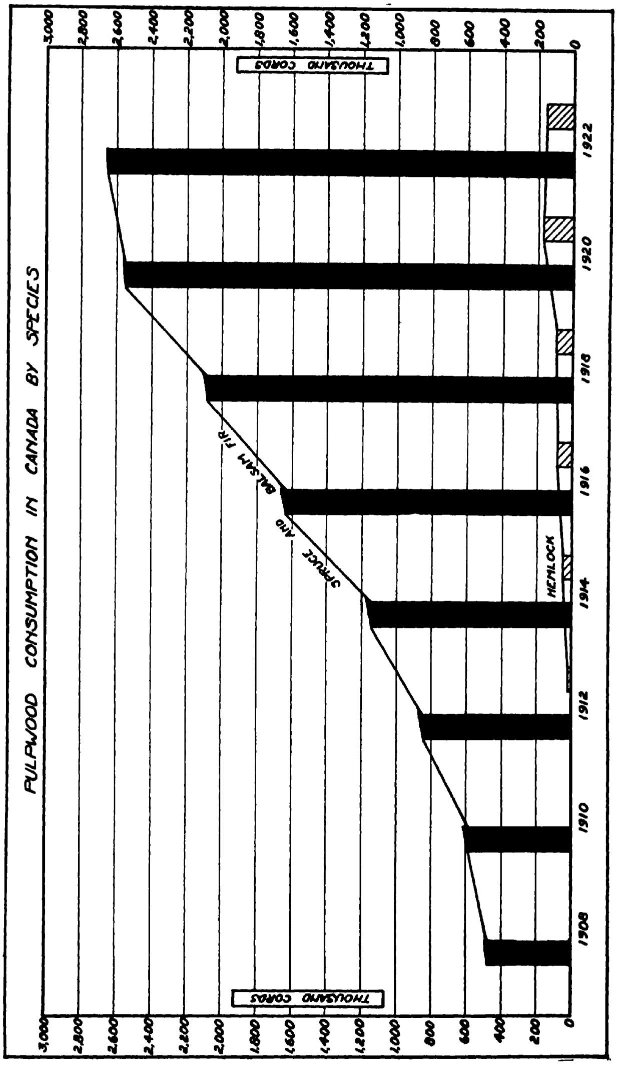


Fig. 46.—Pulpwood consumption in Canada by species, 1908-1922.

for the past 20 years. This is most strikingly reflected in the reports upon the cost to them of the pulpwood used. In 1899, for example, the 1,986,000 cords of pulpwood transformed into wood pulp cost some $9,838,000 laid down at the mills in the United States or at an average of $4.95 per cord. By 1917 the cost per cord had doubled, while in 1920 the 6,114,000 cords that went into the wide variety of papers demanded by the public cost, in round numbers, $116,495,000 or an average of a little more than $19 per cord laid down at the pulp mill. The year 1920, of course, was an extraordinary one in the way of demand and high prices for raw materials. Nevertheless, the high prices for pulpwood in that year were partly the effect of an increasing demand upon a diminishing supply of raw material. They were also augmented by longer freight hauls and higher freight rates. The total freight bill on pulpwood imported into the United States in 1920 has been estimated at $11,000,000.

Some of the items entering into the average cost of pulpwood at the United States mills in 1920 are of particular interest. Domestic spruce, for instance, is reported to have cost $19.97 per cord as against $26.78 per cord for imported spruce. Balsam fir, which usually goes along with spruce, is credited in the 1920 reports with a cost of $19.20 and hemlock with a cost of $14.80 per cord, while yellow pine cost $12.15 per cord at the mill. One of the particular advantages in the cost of both hemlock and yellow pine is that the supply of these woods is relatively close to the point of consumption and this is true also of tamarack, for which the rather small quantity used in 1920 is reported to have cost $12.75 per cord f.o.b. mill.

Among the hardwoods used for the manufacture of paper pulp in the United States mills in 1920 poplar (aspen) cost $17.74 per cord for domestic wood and $18.96 per cord for imported wood. Gum is reported to have cost

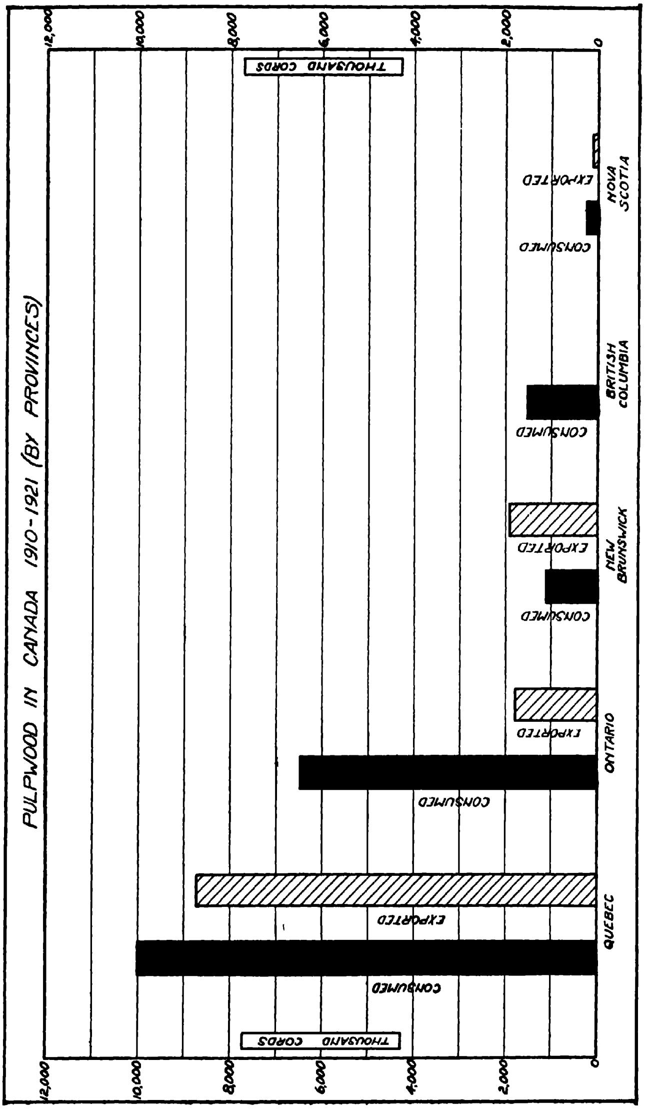


Fig. 47.—Pulpwood in Canada, 1910–1921 (by provinces).

$20.39 per cord, yellow poplar (tulip) $16.67, basswood $18.39 and beech, birch and maple $17.75 per cord.

Canada.—The increase in pulpwood costs in Canada has been similar to that in the United States, although it has not yet reached such high points because of the closer proximity of many of the Canadian mills to their timber supply and the relatively greater quantity of that supply in Canada as compared with the capacity of the industry to absorb it.

According to the Canadian reports, the cost of spruce pulpwood at the mills was $6.04 per cord in 1908 which increased to $10.45 per cord in 1918 and to $16.89 per cord in 1920 with $18.07 and $14.40 per cord in 1921 and 1922 respectively.

In 1921 out of the average of $18.07 per cord for all spruce pulpwood delivered at the Dominion mills, the cost at the Ontario mills was reported as $20.46, in the Quebec mills as $17.85, in the British Columbia mills as $16.09 and in New Brunswick as $12.41 per cord.

The figures upon the cost of balsam fir pulpwood run closely with those of spruce and as a matter of fact it is likely that in a great many cases reports upon these two species are not accurately separated.

First appearing in Canadian reports in 1909, hemlock pulpwood was credited with a cost of $4.51 per cord. This increased to $11.67 in 1918 and further to $15.16 in 1920 with a reported cost of $15.22 and $11.19 per cord in 1921 and 1922 respectively.

British Columbia, of course, is the principal source of supply of hemlock pulpwood and its cost at the mills of that province in 1920 was $15.48 per cord with decreases to $15.17 and $11.11 in 1921 and 1922.

In 1921 the average cost of all kinds of pulpwood laid down at the United States mills was $20.10 per cord and at the Canadian mills $17.55 per cord, while in 1922, the average cost was $16.20 for the pulp mills in the United States and $13.86 per cord for the Canadian mills. Cases

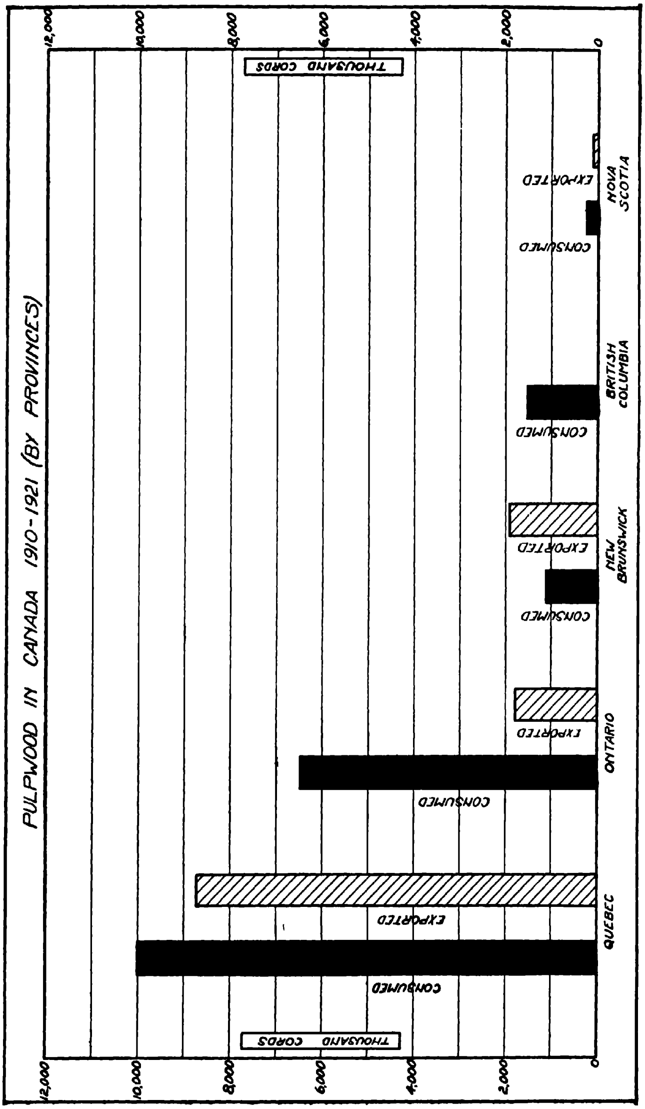


FIG. 47.—Pulpwood in Canada, 1910-1921 (by provinces).

CHAPTER VIII

PROPERTIES OF AMERICAN PULPWOODS

Some kind of pulp can be made from every species of wood, or, for that matter, from almost every vegetable growth, since paper pulp is chiefly cellulose fibers and cellulose is a fundamental constituent of plant structures. The practical question, generally overlooked by enthusiasts and ignored by promoters, is whether any pulp can be made cheaply in sufficient quantities and of a quality which will enable it to compete with other paper-making materials.

Laboratory Determinations.—For many years the Forest Products Laboratory at Madison, Wisconsin, has been testing the principal American woods to determine their pulping qualities by the various chemical processes. In addition to these tests in which a 100-lb. digester was used, a number of woods were tried for mechanical pulp with full-sized equipment in the special groundwood laboratory which was operated for a time at Wausau, Wisconsin, in cooperation with the American Paper and Pulp Association. Not all the native woods which might have some value for pulp have as yet been tested by all the processes, and some woods have been tested which are not likely to be used in any practical undertaking.

In the pages following, the data developed by the Forest Service studies are reproduced in condensed form. A tabular summary of some of the principal items is also given in the Appendix on page 265. In the examination of these reports it should be borne in mind that:

1. The weight is for bone-dry wood per solid cubic foot. This is obtained by multiplying the specific gravity of the oven-dried wood based on the green volume by 62.3 lb. (the weight of a cubic foot of water).

The fiber lengths are the average of all determinations made by the Forest Service and compiled from other sources.

Fig. 48.—The old and the new in timber transportation.

2. The yields are for bone-dry, screened, unbleached pulp per 100 cu. ft. of solid rossed bone-dry wood, it being assumed that this is equivalent to a cord. To convert these yields to the ordinary air-dry

basis of pulp containing 10 per cent moisture, they should be divided by 0.9.

3. The yield of pulp from any given wood depends directly upon the specific gravity of the wood or weight per cubic foot and the pulping method employed. By varying the severity of the pulping treatment both yield and bleach consumption are changed. For example, white spruce sulphite pulp prepared for the manufacture of news print paper, would show an entirely different yield and bleach consumption from bleached white spruce pulp prepared for use in a white bond paper.

4. Since the yields reported are based upon careful experimental runs under controlled conditions with perfect wood, it is not likely that as high figures will be attained in commercial practice.

5. Since absolute comparisons between pulps are somewhat difficult, white spruce has been considered as the standard for the sulphite, sulphate and mechanical processes and aspen for the soda process.

6. No data are given on the possible soda pulping of the various firs, pines, hemlocks, larch, tamarack and other woods that can be reduced by the sulphate process. The laboratory has made extensive pulping trials on the reduction of these woods by the soda process and it is, of course, recognized that this process can be and is at present employed to a limited extent for reduction of certain of these woods. In general, the soda process can be used for reduction of any wood suitable for the production of sulphate pulp.

7. No comparisons are given as to the bleaching of sulphate pulps because little such bleaching has yet been attempted in the American mills. Recent laboratory experiments, however, indicate the feasibility of making a sulphate pulp from the Southern pines that can be bleached to a high white color with a reasonable amount of bleaching agent.

Alder, Red.—*Alnus oregona.* Wt. 28 lb. Fiber 1.2 mm.
Range.—In coast ranges from Southern Alaska to California.
Soda Pulp
Yield 1,160 lb. Soft; a little harder to bleach than aspen.
Possible Uses.—Same as aspen.

Ash, White.—*Fraxinus americana.* Wt. 34 lb. Fiber 1 2 mm.
Range.—From Nova Scotia and Newfoundland to Florida and westward to Ontario and Northern Minnesota, Eastern Nebraska, Kansas, Oklahoma and Texas.
Sulphite Pulp
Yield 1,350 lb. A little hard to bleach.
Easily pulped. Very weak. Poor color.
Possible uses.—Few.
Soda Pulp
Yield 1,350 lb.

Character.—Very difficult to reduce and bleach.

Possible uses.—Few.

Aspen.—*Populus tremuloides.* Wt. 23 lb. Fiber 1.0 mm.

Range.—Southern Labrador to Hudson Bay and northwestward to Alaska; southward to Pennsylvania, Northeastern Missouri, Southern Nebraska, and throughout the Western Mountains to Northern New Mexico and Arizona and Central California; Lower California and Mexico.

Sulphite Pulp

Yield 1,030 lb. Easily bleached.

Easily pulped. Very weak. Excellent color.

Possible uses.—Used with longer fibered stock for better grade of papers.

Soda Pulp

Yield 1,080 lb.

Character.—Soft and short fibered. Easily bleached.

Posible uses.—When bleached and mixed with longer fibered bleached stock is well adapted for book, envelope, and high-grade printings.

Mechanical Pulp

Yield 2,170 lb.

Character.—Short fibered, poor strength, good color but may have black specks present.

Possible uses.—As a filler when used with longer fibered stocks.

Aspen, Largetooth.—*Populus grandidentata.* Wt. 22 lb. Fiber 1.1 mm.

Range.—Nova Scotia through New Brunswick, Southern Quebec, and Ontario to Northern Minnesota; southward to Delaware (and along the Allegheny Mountains to North Carolina, Central Kentucky, and Tennessee), Southern Indiana, and Illinois.

Sulphite Pulp

Yield 1,000 lb.

Character.—Easily pulped and bleached. Very weak but excellent color.

Possible uses.—Used with longer-fibered stock for better grade of papers.

Soda Pulp

Yield 1,000 lb.

Character.—Easily pulped and bleached. Soft, opaque, and short fiber.

Possible uses.—Same as aspen.

Mechanical Pulp

Same as aspen.

Basswood.—*Tilia americana.* Wt. 21 lb. Fiber 1.1 mm.

Range.—New Brunswick to Virginia, Georgia and Alabama; west to Lake Superior and to Lake Winnipeg and Assiniboine River to Eastern Dakota, Eastern Nebraska, Kansas, Oklahoma, and Eastern Texas.

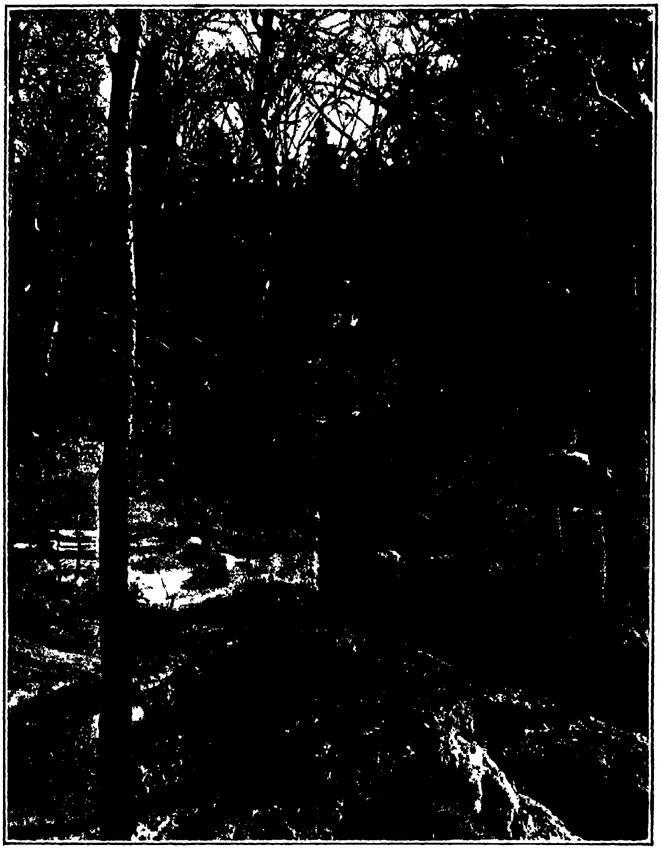


FIG. 49.—A log slide in the woods—a rapid and convenient means of transporting pulpwood for considerable distances down grade.

Soda Pulp

Yield 1,020 lb.

Character.—Soft and easy bleaching.

Possible uses.—Similar to aspen.

Beech.—*Fagus atropunicea.* Wt. 36 lb. Fiber 1.1 mm.

Range.—Nova Scotia to Lake Huron and Northern Wisconsin; south to Western Florida and west to Southeastern Missouri and Texas (Trinity River).

Soda Pulp

Yield 1,530 lb.

Character.—Slightly more difficult to reduce than aspen, soft, easily bleached.

Possible uses.—Same as aspen.

Birch, Paper.—*Betula papyrifera.* Wt. 34 lb. Fiber 1.2 mm.

Range.—From Labrador to Hudson Bay and Alaska; southward to New York and Northern Pennsylvania, Central Michigan and Minnesota, Northern Nebraska, Dakota, Northern Montana and Northwestern Washington.

Sulphite Pulp

Yield 1,500 lb. Difficult to bleach.

Easily pulped. Poor strength and color.

Possible uses.—Few.

Soda Pulp

Yield 1,350 lb.

Character.—More difficult to reduce than aspen, soft, easily bleached.

Possible uses.—Similar to aspen.

Mechanical Pulp

Yield 3,000 lb.

Character.—Pinkish color. Short fiber and poor strength.

Possible uses.—As a filler with long-fibered stocks.

Birch, Yellow.—*Betula lutea.* Wt. 34 lb. Fiber 1.5 mm.

Range.—From Newfoundland and along the Northern shores of the St. Lawrence Gulf to Abitibi Lake and Rainy River; southward to Northern Minnesota and through the Northern States to Eastern Tennessee, North Carolina, and Delaware.

Sulphite Pulp

Yield 1,590 lb. Easily bleached.

Easily pulped. Very weak. Good color.

Possible uses.—Same as aspen.

Soda Pulp

Yield 1,360 lb.

Character.—More difficult to reduce than aspen, soft, easily bleached.

Possible uses.—Same as aspen.

Boxelder.—*Acer negundo.* Wt. 30 lb. Fiber ——.

Range.—Vermont, New York, Eastern Pennsylvania, and south to Florida; northwestward to Winnipeg, Montana, Utah, Western Texas, New Mexico, and Eastern Arizona.

Sulphite Pulp

Probably the same as red maple

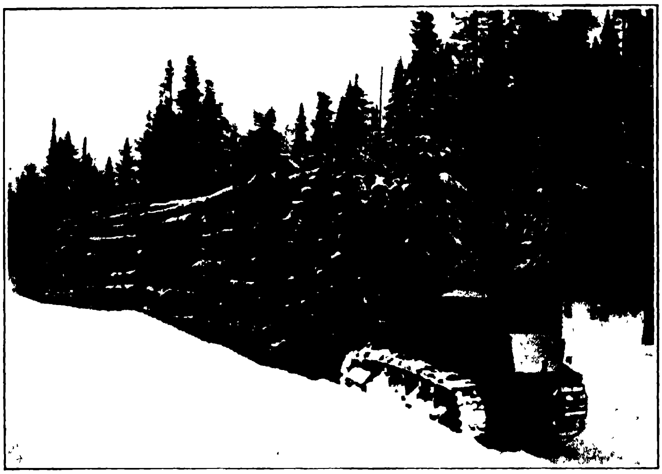


FIG. 50.—A tractor hauling nearly 800 pieces of 16-foot spruce pulpwood equivalent to 76 cords in the Adirondacks.

Soda Pulp

Yield 1,300 lb.

Character.—Easily pulped. Rather difficult to bleach. Soft, opaque and short fiber.

Possible uses.—Same as aspen.

Mechanical Pulp

Probably the same as black gum.

Buckeye.—*Aesculus glabra.* Wt. 21 lb. Fiber ——.

Range.—From Pennsylvania to Northern Alabama and west to Southern Iowa, Central Kansas, and Oklahoma.

Sulphite Pulp

Yield 940 lb.

Character.—Easily pulped. Rather difficult to bleach. Silver-gray color.

Possible uses.—Same as aspen.

Soda Pulp

Yield 940 lb.

Character.—Fairly easily pulped. Rather difficult to bleach. Soft, opaque, short fiber.

Possible uses.—Same as aspen.

Butternut.—*Juglans cinerea.* Wt. 22 lb. Fiber 1.2 mm.

Range.—Southern New Brunswick to Delaware and on the Appalachian Mountains to Georgia and Alabama; westward through Ontario to Dakota, Southeastern Nebraska, Southern Missouri, and Northeastern Arkansas.

Sulphite Pulp

Yield 1,000 lb.

Character.—Easily pulped and bleached. Weak and poor color.

Possible uses.—Same as aspen.

Soda Pulp

Yield 1,000 lb.

Character.—Easily pulped. Difficult to bleach. Short, opaque fiber.

Possible uses.—Same as aspen.

Catalpa.—*Catalpa catalpa.* Wt. 31 lb. Fiber ——.

Range.—Supposed to be indigenous only in Southwestern Georgia, Western Florida, Central Alabama and Mississippi but widely cultivated and naturalized elsewhere east of the Rocky Mountains.

Sulphite Pulp

Yield 1,390 lb.

Character.—Fairly easily pulped. Difficult to bleach. Short fiber, specky and pink.

Possible uses.—Same as aspen.

Soda Pulp

Yield 1,340 lb.

Character.—Easily pulped and bleached. Short, opaque fiber.

Possible uses.—Same as aspen.

Cedar, Incense.—*Libocedrus decurrens.* Wt. 23 lb. Fiber 2.0 mm.

Range.—From Oregon and southward on the Western slope of the Cascade Mountains through California, Western Nevada; Lower California.

Sulphite Pulp

Yield 920 lb. Difficult to bleach.

Good strength. Poor color.

Possible uses.—Few.

Sulphate Pulp

Yield 950 lb.

Character.—Dark colored, strong and hard fiber.

Possible uses.—As a substitute for white spruce.

Cedar, Port Orford.—*Chamaecyparis lawsoniana.* Wt. 26 lb. Fiber 3.6 mm.

Range.—Coast region from Southwestern Oregon to California, extending inland about 40 miles.

Sulphite Pulp

Yield 1,150 lb.

Character.—Fairly easily pulped. Rather difficult to bleach. Fair strength and color.

Possible uses.—Same as white spruce.

Sulphate Pulp

Yield 960 lb.

Character.—Difficult to pulp and bleach. Good strength. Hard and fine fiber.

Possible uses.—Same as white spruce.

Fig. 51.—Typical construction of a timber dam in logging operations.

Cedar, Red.—*Juniperus virginiana.* Wt. 27 lb. Fiber 2.8 mm.

Range.—Nova Scotia and New Brunswick to Florida and west in Ontario to Dakota, Central Nebraska, Kansas and Oklahoma.

Sulphite Pulp

Yield 1,300 lb.

Character.—Difficult to pulp and bleach. Very shivey and dark colored.

Possible uses.—Few.

Sulphate Pulp

Yield 1,000 lb.

Character.—Difficult to pulp and bleach. Shivey but fairly strong and fine fibered.

Possible uses.—Wrappings.

Cedar, Southern White.—*Chamaecyparis thyoides.* Wt. 20 lb. Fiber 2.1 mm.

Range.—Coast region from Southern Maine to Northern Florida and westward to Mississippi.

Yield 1,000 lb.

Character.—Fairly easy to pulp. Rather difficult to bleach. Fair strength and color.

Sulphate Pulp

Yield 780 lb.

Character.—Readily pulped. Difficult to bleach. Hard and fine fiber.

Possible uses.—As a substitute for spruce.

Cedar, Western Red.—*Thuja plicata.* Wt. 19 lb. Fiber 3.8 mm.

Range.—From coast of Southern Alaska to Northern California; eastward through British Columbia and Northern Washington to Northern Idaho and Montana; western slopes Rocky Mountains.

Sulphite Pulp

Yield 830 lb.

Character.—Difficult to bleach. Dark colored but fair strength.

Possible uses.—Few.

Sulphate Pulp

Yield 830 lb.

Character.—Rather difficult to bleach. Fair strength.

Possible uses.—Same as white spruce.

Cottonwood.—*Populus deltoides.* Wt. 23 lb. Fiber 1.3 mm.

Range.—From Quebec and Vermont through western New England and New York, Pennsylvania, Maryland, and Atlantic States to Western Florida and west to the Rocky Mountains from Southern Alberta to Northern New Mexico.

Sulphite Pulp

Yield 1,035 lb. Easily bleached.

Easily pulped. Very weak. Excellent color.

Possible uses.—Same as aspen.

Soda Pulp

Yield 1,030 lb.

Character.—Soft and easily bleached.

Possible uses.—Same as aspen.

Mechanical Pulp

Yield 2,180 lb.

Character.—Short-fibered, weak, good color.

Possible Uses.—As a filler when used with longer-fibered stocks.

Cucumber.—*Magnolia acuminata.* Wt. 27 lb. Fiber 1.3 mm.

Range.—From Western New York through Southern Ontario to Southen Illinois and south in the Appalachian Mountains to Southern Alabama and Northeastern Mississippi; Central Kentucky and Tennessee.

Sulphite Pulp

Yield 1,250 lb.

Character.—Easily pulped, very weak. Dark colored. Difficult to bleach.

Possible uses.—Few.

Fig. 52.—The most important man in the logging camp—the cook.

Soda Pulp

Yield 1,200 lb.

Character.—A little harder to reduce and bleach than aspen.

Possible uses.—Same as aspen.

Cypress.—*Taxodium distichum.* Wt. 27 lb. Fiber 3.3 mm.

Range.—From Southern Delaware to Florida; westward in the Gulf coast region to Texas and northward through Louisiana, Arkansas, and Eastern Mississippi and Tennessee, Southeastern Missouri, Western and Northwestern Kentucky, Southern Illinois, and Southwestern Indiana.

Sulphite Pulp

Yield 1,160 lb. Very difficult to bleach.

Difficult to cook. Poor strength and color.

Possible uses.—Few.

Sulphate Pulp

Yield 1,350 lb.

Character.—Fiber long but tender.

Possible uses.—As a substitute for white spruce.

Douglas Fir.—*Pseudotsuga taxifolia.* Washington and Oregon. Wt. 28 lb. Fiber 4.4 mm. Montana and Wyoming. Wt. 25 lb. Fiber ——.

Range.—Rocky Mountain region northward to Central British Columbia; Pacific Coast.

Sulphite Pulp

Yield 1,200 lb. Difficult to bleach. Hard to pulp.

Fair strength. Poor color. Pitchy.

Possible uses.—Few.

Sulphate Pulp

Yield 1,178 lb.

Character.—Good grade of kraft pulp but not as strong as white spruce.

Possible uses.—Similar to white spruce.

Mechanical Pulp

Because of high pitch content is probably unsuitable for the purpose.

Elm, Cork.—*Ulmus racemosa.* Wt. 36 lb. Fiber 1.32 mm.

Range.—From Quebec through Ontario, and south through Northwestern New Hampshire to Southern Vermont; westward through Northern New York, Southern Michigan, and Wisconsin to Northeastern Nebraska, Southeastern Missouri and Middle Tennessee.

Sulphite Pulp

Yield 1,620 lb.

Character.—More difficult to pulp and bleach than aspen; poor color and strength.

Possible uses.—Few.

Soda Pulp

Yield 1,620 lb.

Character.—Easily pulped and bleached; soft, and short-fibered.

Possible uses.—Same as aspen.

Elm, Slippery.—*Ulmus pubescens.* Wt. 30 lb. Fiber 1.7 mm.

Range.—From Lower St. Lawrence River through Ontario to North Dakota and Eastern Nebraska; south to Western Florida, Central Alabama, Mississippi, and Texas.

Sulphite Pulp

Yield (?)

Character.—Difficult to pulp.

Soda Pulp

Yield 1,260 lb.

Character.—Easily pulped. Rather difficult to bleach. Short fiber.

Possible uses.—Same as aspen.

Elm, White.—*Ulmus americana.* Wt 27 lb. Fiber 1.6 mm.

Range.—From Southern Newfoundland to Lake Superior and the eastern base of the Rocky Mountains, south to Dakota, Nebraska, Kansas, Texas, and Florida.

Soda Pulp

Yield 1,080 lb.

Character.—Easily pulped. Fairly easily bleached. Short fiber.

Possible uses.—Same as aspen.

FIG. 53.—Douglas fir logs in the state of Washington.

Fir, Alpine.—*Abies lasiocarpa.* Wt. 21 lb. Fiber ——.

Range.—Rocky Mountain region from Colorado to Montana and Idaho, and westward through Northern Oregon and northward to Alaska.

Sulphite Pulp

Yield 1,010 lb. Easily bleached.

Easily pulped. Good strength. Excellent color.

Possible uses.—As a substitute for white spruce.

Sulphate Pulp

Yield 1,050 lb.

Character.—Long fiber. Excellent strength.

Possible uses.—Same as white spruce.

Mechanical Pulp
Yield 2,070 lb.
Character.—White fiber, fair strength.
Possible uses.—Same as white spruce.

Fir, Balsam.—*Abies balsamea.* Wt. 21 lb. Fiber 2.7 mm.
Range.—From Newfoundland and Labrador to Hudson Bay and northwestward to Great Bear Lake region, and south to Virginia, Michigan and Minnesota.
Sulphite Pulp
Yield 970 lb. Easily bleached.
Easily pulped. Good strength. Excellent color.
Possible uses.—As a substitute for white spruce.
Sulphate Pulp
Yield 1,010 lb.
Character.—High-grade kraft fiber.
Possible uses.—Same as white spruce.
Mechanical Pulp
Yield 1,910 lb.
Character.—Good fiber length, strong and good color.
Possible uses.—Same as white spruce.

Fir, Grand.—*Abies grandis.* Wt. 23 lb. Fiber 3.2 mm.
Range.—Coast region from Vancouver Island to California and from Washington and Oregon to Northern Idaho and Montana.
Sulphite Pulp
Yield 980 lb. Easily bleached.
Easily pulped. Fair strength. Excellent color.
Possible uses.—Same as white spruce.
Mechanical Pulp
Yield 1,950 lb.
Character.—Good fiber, color and strength.
Possible uses.—Same as white spruce.

Fir, Noble.—*Abies nobilis.* Wt. 22 lb. Fiber ——.
Range.—Washington to Oregon. Range at present but little known.
Sulphite Pulp
Yield 1,010 lb. Easily bleached.
Easily pulped. Fair strength. Excellent color.
Possible uses.—As a substitute for white spruce.
Sulphate Pulp
Yield 1,080 lb.
Character.—Good quality of strong pulp.
Possible uses.—Same as white spruce.
Mechanical Pulp
Yield 1,920 lb.

Character.—Very long strong fiber. Good color.

Possible uses.—Same as white spruce.

Fir, Red.—*Abies magnifica.* Wt. 23 lb. Fiber ——.

Range.—Southern Oregon and California.

Sulphite Pulp

Yield 1,080 lb. A little hard to bleach.

Easily pulped. Good strength. Fair color.

Possible uses.—As a substitute for white spruce.

Sulphate Pulp

Yield 1,150 lb.

Character.—Good, strong fiber.

Possible uses.—Same as white spruce.

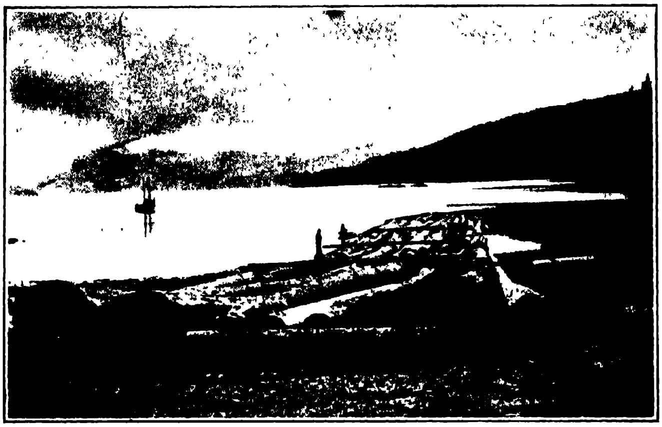


Fig. 54.—A raft of spruce logs averaging 78 feet in length in Southeastern Alaska.

Mechanical Pulp

Yield 1,915 lb.

Character.—Pinkish color. Fair strength.

Possible uses.—As a substitute for white spruce.

Fir, Silver.—*Abies amabilis.* Wt. 22 lb. Fiber ——.

Range.—From British Columbia (Fraser River and southward in the Cascade Mountains) to Washington and Oregon.

Sulphite Pulp

Yield 1,060 lb. Easily bleached.

Easily pulped. Fair strength. Excellent color.

Possible uses.—As a substitute for white spruce.

Sulphate Pulp

Yield 1,100 lb.

Character.—Long fiber, excellent strength.

Possible uses.—Same as white spruce.

Mechanical Pulp

Yield 1,870 lb.

Character.—Long fiber of excellent strength; color slightly grayish.

Possible uses.—Same as white spruce.

Fir, White.—*Abies concolor.* Wt. 22 lb. Fiber 3.5 mm.

Range.—Oregon to Southern California, Arizona and New Mexico to Colorado and Utah.

Sulphite Pulp

Yield 950 lb. Easily bleached.

Easily pulped. Good strength. Good color.

Possible uses.—As a substitute for white spruce.

Sulphate Pulp

Yield 1,100 lb.

Character.—Good strong grade of kraft pulp.

Possible uses.—Same as white spruce.

Mechanical Pulp

Yield 2,010 lb. Satisfactory color. Fair strength. Good fiber.

Possible uses.—Same as white spruce.

Gum, Black.—*Nyssa sylvatica.* Wt. 30 lb. Fiber 1.7 mm.

Range.—From Maine to Florida and west to Southern Ontario, Southern Michigan, Southeastern Missouri and Texas.

Soda Pulp

Yield 1,300 lb.

Character.—Soft; a little harder to cook and bleach than aspen

Mechanical Pulp

Yield 2,610 lb.

Character.—Very short, but tough fiber, very white color.

Possible uses. As a filler with longer-fibered stock.

Gum, Red.—*Liquidambar styraciflua.* Wt. 27 lb. Fiber 1.6 mm.

Range.—From Connecticut to Southeastern Missouri and Arkansas; south to Florida and Texas.

Sulphite Pulp

Yield 1,190 lb. Difficult to bleach.

Easily pulped. Very poor strength. Dark colored.

Possible uses.—Few.

Soda Pulp

Yield 1,080 lb.

Character.—A little more difficult to reduce than aspen. Soft and hard to bleach.

Possible uses.—Same as aspen.

Gum, Tupelo.—*Nyssa aquatica.* Wt. 29 lb. Fiber 1.6 mm.

Range.—Coast region from Southern Virginia to Northern Florida, and through the Gulf States to Texas; northward through Arkansas, West Tennessee and Kentucky, Southern and Southeastern Missouri and Southern Illinois

Sulphite Pulp

Yield 1,160 lb. Easily bleached.

Easily pulped. Poor strength. Fair color.

Possible uses.—Same as aspen.

Fig. 55.—Breaking a log jam.

Soda Pulp

Yield 1,200 lb.

Character.—Soft, but harder to bleach than aspen.

Possible uses.—Similar to aspen.

Hackberry.—*Celtis occidentalis.* Wt. 30 lb. Fiber 1.1 mm.

Range.—Widely scattered throughout the United States and Canada.

Sulphite Pulp

Yield 1,300 lb.

Character.—Easily pulped and bleached. Short fiber exceptionally light colored.

Possible uses.—Same as aspen.

Soda Pulp

Yield 1,200 lb.

Character.—Easily pulped. Rather difficult to bleach. Short fiber not very opaque.

Possible uses.—Same as aspen.

Hemlock, Carolina.—*Tsuga caroliniana.* Wt. 30 lb. Fiber ——.

Range.—Mountains of Southwestern Virginia, Western North Carolina, and Northern Georgia; very local.

Sulphite Pulp

Yield 1,290 lb.

Character.—Fairly easily pulped. A little hard to bleach. Good strength and fair color.

Possible uses.—As a substitute for white spruce.

Sulphate Pulp

Yield 1,260 lb.

Character.—Good strong pulp.

Possible uses.—As a substitute for white spruce.

Mechanical Pulp

Probably the same as hemlock.

Hemlock, Eastern.—*Tsuga canadensis.* Wt. 24 lb. Fiber 3.0 mm.

Range.—Nova Scotia to Minnesota, Wisconsin, Michigan, and southward in the Atlantic region along the mountains to Northern Alabama and Georgia.

Sulphite Pulp

Yield 1,080 lb. A little hard to bleach.

Not easily pulped. Good strength. Fair color.

Possible uses.—As a substitute for white spruce.

Sulphate Pulp

Yield 1,150 lb. Good strong pulp.

Possible uses.—Similar to white spruce.

Mechanical Pulp

Yield 2,030 lb. Pinkish color. Short fiber.

Possible uses.—As a substitute for white spruce.

Hemlock, Western.—*Tsuga heterophylla.* Wt. 23 lb. Fiber 2.7 mm.

Range.—Alaska to Idaho and Montana and southward to California.

Sulphite Pulp

Yield 1,050 lb. Easily bleached.

Easily pulped. Good strength. Fair color.

Possible uses.—Same as white spruce.

Sulphate Pulp

Yield 1,100 lb.

Character.—Good strong fiber.

Possible uses.—Similar to white spruce.

Mechanical Pulp

Yield 2,160 lb.

Character.—Good strength and fiber. Grayish color.

Possible uses.—Similar to white spruce.

Hickory, Mockernut.—*Hicoria alba.* Wt. 40 lb. Fiber 1.4 mm.

Range.—Ontario to Florida, west to Missouri, Eastern Kansas, Oklahoma and Texas.

Sulphite Pulp

Yield 1,680 lb.

Character.—Difficult to pulp. Readily bleached. Short fiber.

Possible uses.—Same as aspen.

Soda Pulp

Yield 1,380 lb.

Character.—Readily pulped. Difficult to bleach. Short fiber.

Possible uses.—Same as aspen.

FIG. 56.—Cottonwood logs at a paper mill.

Larch, Western.—*Larix occidentalis.* Wt. 28 lb. Fiber 2.6 mm.

Range.—Southern British Columbia and south in the Cascade Mountains to the Columbia River and to Western Montana; also in Blue Mountains of Washington and Oregon.

Sulphite Pulp

Yield 1,200 lb. Difficult to bleach. Difficult to pulp. Poor strength and color.

Possible uses.—Low-grade wrappings.

Sulphate Pulp

Yield 1,290 lb.

Character.—Good quality of kraft fiber.

Possible uses.—Same as white spruce.

Mechanical Pulp

Yield 2,100 lb.

Character.—Brown color, short fiber and fair strength.

Possible uses.—Where a medium quality of groundwood will answer the purpose.

Locust.—*Robinia pseudacacia.* Wt. 41 lb. Fiber ——.

Range.—From Pennsylvania to Northern Georgia. Widely naturalized through cultivation and other agencies throughout the United States east of the Rocky Mountains.

Sulphite Pulp

Yield 1,970 lb.

Character.—Difficult to pulp. Very difficult to bleach. Short fiber.

Possible uses.—Few.

Soda Pulp

Yield 1,700 lb.

Character.—Fairly easily pulped. Very difficult to bleach. Short, opaque soft fiber.

Possible uses.—Same as aspen.

Magnolia, Sweet.—*Magnolia glauca.* Wt. 39 lb. Fiber 1.3 mm.

Range.—Massachusetts (local); from New Jersey to Florida; west in the Gulf region to Texas.

Sulphite Pulp

Yield 1,680 lb.

Character.—Easily pulped and bleached. Fair strength. Poor color.

Possible uses.—Can be used without pulps from conifers in manufacturing of book, magazine, and similar papers.

Soda Pulp

Yield 1,680 lb.

Character.—Easily pulped. Rather difficult to bleach. Soft, opaque fiber.

Possible uses.—Same as aspen.

Mechanical Pulp

Probably similar to black gum.

Maple, Red.—*Acer rubrum.* Wt. 30 lb. Fiber 0.8 mm.

Range.—From New Brunswick, Quebec, and Ontario to Florida; west to Lake of the Woods, Eastern Dakota and Nebraska, Oklahoma and Texas.

Sulphite Pulp

Yield 1,450 lb.

Character.—Easily pulped and bleached. Very weak and rather poor color.

Possible uses.—Same as aspen.

Soda Pulp

Yield 1,300 lb.

Character.—Easily pulped and bleached. Soft opaque and short fiber.

Possible uses.—Same as aspen.

Mechanical Pulp

Probably the same as black gum.

Maple, Sugar.—*Acer saccharum*. Wt. 35 lb. Fiber ——.

Range.—From Southern Newfoundland through Quebec and Ontario to Minnesota; south to Northern Georgia and Western Florida; west to Eastern Nebraska, Kansas and Texas.

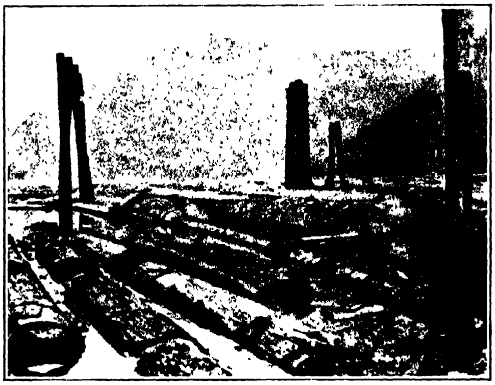


Fig. 57.—Some extra-fine spruce at a British Columbia paper mill.

Sulphite Pulp

Yield 1,540 lb.

Character.—Easily pulped and bleached. Very weak but excellent color.

Possible uses.—Same as aspen.

Soda Pulp

Yield 1,500 lb.

Character.—More difficult to pulp and bleach than aspen. Soft, opaque, short fiber.

Possible uses.—Same as aspen.

Mechanical Pulp

Probably similar to black gum.

Oak, Red.—*Quercus rubra*. Wt. 35 lb. Fiber 1.5 mm.

Range.—Nova Scotia and Southern New Brunswick through Quebec and along the north shores of Lake Huron to near Lake Namekagon; south to Middle Tennessee and Virginia, and along the Appalachian Mountains to Northern Georgia; west to Eastern Nebraska, Central Kansas.

Sulphite Pulp

Yield 1,600 lb. Easily bleached.

Easily pulped. Very weak. Poor color.

Possible uses.—Few.

Soda Pulp

Yield 1,400 lb.

Character.—Very difficult to pulp and bleach.

Possible uses.—Few.

Oak, White.—*Quercus alba.* Wt. 37 lb. Fiber 1.5 mm.

Range.—From Southern Maine to Southwestern Quebec and through Central and Southern Ontario, lower peninsula of Michigan and Southern Minnesota to Southeasern Nebraska and Eastern Kansas; south to Northern Florida and Texas.

Sulphite Pulp

Yield 1,600 lb.

Character.—Difficult to pulp and bleach.

Possible uses.—Few.

Soda Pulp

Yield 1,480 lb.

Character.—Difficult to pulp and bleach.

Possible uses.—Few.

Palmetto, Cabbage.—*Sabal palmetto.* Wt. 23 lb. Fiber ——.

Range.—Coast region from North Carolina to Florida.

Sulphate Pulp

Yield 1,400 lb.

Character.—Readily pulped to low pressure. Fairly easily bleached. Pithy fiber of fair felting properties.

Possible uses.—In the manufacturing of book, magazine and similar papers.

Soda Pulp

Yield 1,150 lb. of a low-grade pithy fiber.

Character.—Coarse, tender fiber. Impossible to bleach. Poor color.

Possible uses.—Few.

Pine, Cuban.—*Pinus heterophylla.* Wt. 37 lb. Fiber ——.

Range.—Coast region, from South Carolina to Southern Florida and west to Louisiana.

Sulphite Pulp

Because of high pitch content is probably unsuitable for this purpose.

Sulphate Pulp

Yield 1,650 lb.

Character.—Strong, but coarse fiber.

Possible Uses.—Similar to white spruce.

Mechanical Pulp

Because of high pitch content is probably unsuitable for this purpose.

Pine, Jack.—*Pinus divaricata.* Wt. 24 lb. Fiber 2.5 mm.

Range.—New Brunswick to New Hampshire and west through Great Lake and Hudson Bay region to Great Bear Lake, Mackenzie River, and Rocky Mountains; south into northern Maine, northern Indiana and Illinois, and central Minnesota.

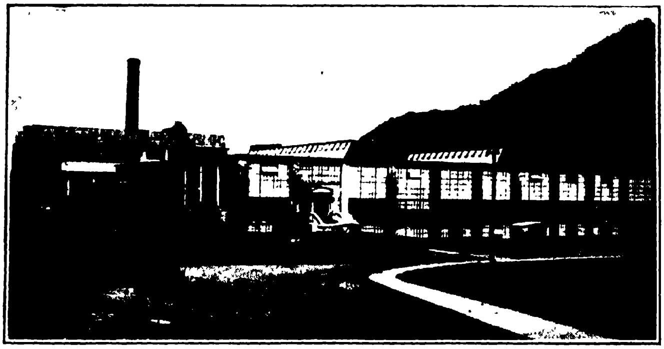


FIG. 58.—A paper mill in the Berkshires

Sulphite Pulp

Yield 1,080 lb. Very difficult to bleach.

Not easily pulped—fair strength—poor color.

Pulp shivey and full of pitch.

Possible Uses.—Mechanical difficulties when running this pulp over the paper machine prevent its use in many places.

Sulphate Pulp

Yield 1,150 lb.

Character.—Very strong, tough fiber.

Possible Uses.—Similar to white spruce.

Mechanical Pulp

Yield 2,130 lb.

Character.—Gray, somewhat soft, good strength, pitchy, poor finish.

Possible Uses.—Medium grades of groundwood.

Pine, Limber.—*Pinus flexilis.* Wt. 23 lb. Fiber ——.

Range.—Rocky Mountain region from Montana to Western Texas and New Mexico; Northern Arizona, Utah, Nevada, and California.

Sulphite Pulp

Yield 1,000 lb.

Character.—Difficult to pulp and bleach.

Fair strength but shivey and poor color.

Possible Uses.—Few.

Sulphate Pulp

Yield 1,040 lb.

Character.—Good strength and color.

Fairly easily bleached.

Possible Uses.—Similar to white spruce.

Mechanical Pulp

Probably the same as white pine.

Pine, Loblolly.—*Pinus taeda.* Wt. 30 lb. Fiber 3.0 mm.

Range.—South Atlantic and Gulf States from New Jersey, Southern Delaware and West Virginia to Central Florida and west to Eastern Texas; northward into Southeastern Oklahoma, Arkansas, and southern border of Middle and West Tennessee.

Sulphite Pulp

Yield 1,140 lb. Difficult to bleach.

Easily pulped, good strength and color.

Possible Uses.—As a substitute for white spruce.

Sulphate Pulp

Yield 1,420 lb.

Character.—Strong but coarse fiber.

Possible Uses.—Similar to white spruce.

Mechanical Pulp

Yield 2,450 lb.

Character.—Short fiber and very pitchy.

Possible Uses.—Only when mixed with better grades of groundwood fiber.

Pine, Lodgepole.—*Pinus murrayana.* Wt. 24 lb. Fiber 2.3 mm.

Range.—From Alaska and southward through interior British Columbia; the mountains of Washington and Oregon to California; plateau east of the Rocky Mountains to New Mexico and Northern Arizona.

Sulphite Pulp

Yield 1,080 lb. A little hard to bleach.

Easily pulped. Excellent strength and color.

Possible Uses.—As a substitute for white spruce.

Sulphate Pulp

Yield 1,120 lb.

Character and Uses.—Same as white spruce.

Mechanical Pulp

Yield 2,140 lb.

Character and Uses.—A little pitchy, but otherwise similar to white spruce.

Note.—The lodgepole pine which grows in the lowlands in the coastal region is very similar to jack pine. The Rocky Mountain region lodgepole pine, however, contains much less pitch and is to be preferred for sulphite and mechanical pulps.

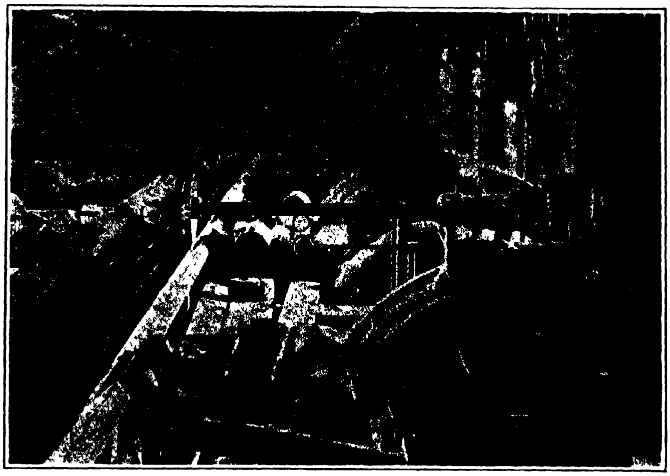


FIG. 59.—Disc barkers in a pulp mill.

Pine, Longleaf.—*Pinus palustris.* Wt. 34 lb. Fiber 3.7 mm.

Range.—Coast region, from Southern Virginia to Florida to Eastern Texas; northward in Alabama to the northeastern part of the state and Northwestern Georgia.

Sulphite Pulp

Yield 1,840 lb. (crude pulp). Cannot be economically bleached. Very poor color. In general, this wood cannot be considered satisfactory for sulphite pulp.

Possible Uses.—Few.

Sulphate Pulp

Yield 1,600 lb.

Character.—Strong, but coarse fiber.

Possible Uses.—Similar to white spruce.

Pine, Norway, Red.—*Pinus resinosa.* Wt. 27 lb. Fiber 3.7 mm.

Range.—From Newfoundland and along the northern shores of St. Lawrence Gulf to Northern Ontario to Southern Manitoba; southward through the Northern States to Massachusetts, Pennsylvania, Northeastern Ohio, Central Michigan, Northern Wisconsin, and Northeastern Minnesota.

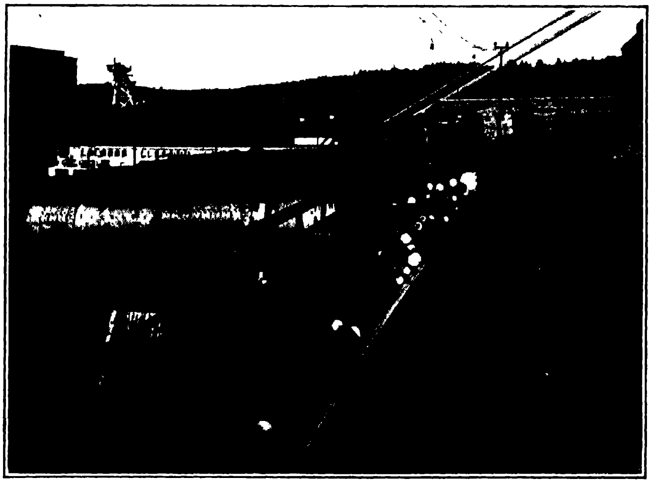


FIG. 60.—Drum barkers at a large paper mill.

Sulphite Pulp

Yield 1,230 lb.

Character.—Difficult to pulp and bleach—poor strength.

Possible Uses.—Few.

Sulphate Pulp

Yield 1,350 lb.

Character and Possible Uses.—Similar to white spruce.

Mechanical Pulp

Because of high pitch content is probably unsuitable for this purpose.

Pine, Pinon.—*Pinus edulis.* Wt. 31 lb. Fiber 2.0 mm.

Range.—From Colorado through New Mexico to Western Texas.

Sulphite Pulp

Yield 1,330 lb.

Character.—Easily pulped. Difficult to bleach. Fair strength, somewhat shivey, and fair color.

Possible Uses.—Wrappings.

Sulphate Pulp

Yield 1,300 lb.

Character and Uses.—Similar to white spruce.

Mechanical Pulp

Probably the same as white pine.

Pine, Pitch.—*Pinus rigida.* Wt. 29 lb. Fiber ——.

Range.—From Southern New Brunswick to Eastern Ontario and southward in the Atlantic region to Southern Virginia and along the mountains to Northern Georgia, west to Western New York, Northeastern Pennsylvania, Eastern Ohio and Kentucky, Eastern Tennessee.

Sulphite Pulp

Yield 1,250 lb.

Character.—Difficult to pulp and bleach—poor strength—pitchy.

Possible Uses.—Few.

Sulphate Pulp

Yield 1,430 lb.

Character and Uses.—Similar to white spruce.

Mechanical Pulp

Because of high pitch content is probably unsuitable for this purpose.

Pine, Pond.—*Pinus serotina.* Wt. 31 lb. Fiber ——.

Range.—Coast region from North Carolina to Florida. Range imperfectly known.

Sulphite Pulp

Yield 1,360 lb.

Character.—Fairly easily pulped and bleached. Fair color.

Possible Uses.—As a substitute for spruce.

Sulphate Pulp

Yield 1,400 lb.

Character.—Strong, but coarse fiber. Fairly easily bleached. Similar to white spruce.

Mechanical Pulp

Probably the same as loblolly pine.

Pine, Sand.—*Pinus clausa.* Wt. 29 lb. Fiber ——.

Range.—Coast of Alabama and Western Florida; east coast of Florida from St. Augustine to Halifax River.

Sulphite Pulp

Yield 1,300 lb.

Character.—Difficult to bleach, and shivey. Easily pulped. Fair strength. Good color.

Possible Uses.—As a substitute for white spruce.

Sulphate Pulp

Yield 1,220 lb.

Character and Uses.—Similar to white spruce.

Mechanical Pulp

Because of high pitch content is probably unsuitable for this purpose.

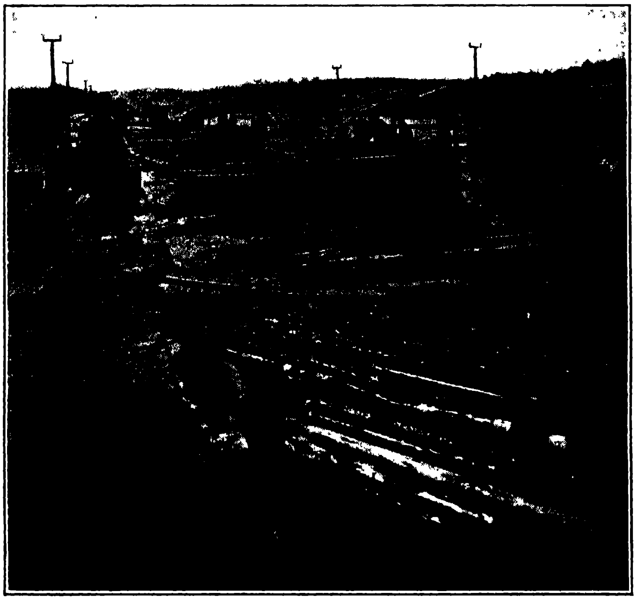


FIG. 61.—Pulpwood in the log pond on the way to the slashers.

Pine, Scotch.—*Pinus sylvestris*. Wt. 37 lb. Fiber ——.

Range.—Europe and Northern Asia up to 700 feet above sea level in the far north; 6,500 feet in Southern Europe.

Sulphite Pulp

Yield 1,600 lb.

Character.—Difficult to pulp and bleach, poor strength and pitchy.

Possible Uses.—Few.

Sulphate Pulp

Yield 1,600 lb.

Character.—Strong, tough fiber.

Possible Uses.—Similar to white spruce.

Mechanical Pulp

Because of pitch content is probably unsuitable for this purpose.

Pine, Scrub.—*Pinus virginiana.* Wt. 26 lb. Fiber 2.8 mm.

Range.—From New York (Staten Island) to South Carolina and Northern Alabama, west into Southern Indiana and Middle Tennessee.

Sulphite Pulp

Yield 1,000 lb.

Character.—Difficult to bleach, easily pulped, and good color.

Possible Uses.—As a substitute for spruce.

Sulphate Pulp

Yield 1,250 lb.

Character.—Strong, but coarse fiber.

Possible Uses.—Similar to white spruce.

Pine, Shortleaf.—*Pinus echinata.* Wt. 31 lb. Fiber 3.7 mm.

Range.—From New York (Staten Island) to Florida and west to Southern Missouri, Eastern Oklahoma and Northeastern Texas.

Sulphite Pulp

Yield 1,500 lb.

Character.—Difficult to pulp and bleach. Pitchy.

Possible Uses.—Few.

Sulphate Pulp

Yield 1,450 lb.

Character.—Strong, but coarse fiber.

Possible Uses.—Similar to white spruce.

Mechanical Pulp

Because of pitch content is probably unsuitable for this purpose.

Pine, Sugar.—*Pinus lambertiana.* Wt. 23 lb. Fiber 4.1 mm.

Range.—Oregon and California.

Sulphite Pulp

Yield 1,010 lb.

Character.—A little difficult to bleach Easily pulped. Poor strength, fair color.

Possible Uses.—Dark-colored wrappings.

Sulphate Pulp

Yield 1,150 lb.

Character and Uses.—Similar to white spruce.

Pine, Western Yellow.—*Pinus ponderosa.* Wt. 24 lb. Fiber 3.6 mm.

Range.—From South Dakota, Western Texas, and Mexico to the Pacific Coast region and British Columbia.

Sulphite Pulp

Yield 1,130 lb.

Character.—Difficult to bleach, shivey. Not difficult to pulp. Very poor strength and color.

Possible Uses.—Few.

Sulphate Pulp

Yield 1,100 lb.

Character.—Fine, high grade, very strong, and tough fiber.

Possible Uses.—Same as white spruce.

Mechanical Pulp

Yield 2,060 lb.

Character.—Fibers are long, coarse and soft, creamy color and somewhat pitchy.

Possible Uses.—Where a medium quality of groundwood will answer the purpose.

Pine, White.—*Pinus strobus.* Wt. 22 lb. Fiber 3.8 mm.

Range.—From Newfoundland and along the northern shores of St. Lawrence Gulf to Northern Ontario, Southern Manitoba; southward through Northern and Eastern Minnesota, northeastern and eastern border of Iowa, Northern Illinois, southern shores of Lake Michigan, Southern Michigan, Northeastern and Eastern Ohio, and along the Allegheny Mountains to Northern Georgia.

Sulphite Pulp

Yield 1,210 lb.

Character.—Difficult to bleach. Difficult to pulp. Fair strength, but shivey and poor color.

Possible Uses.—Few.

Sulphate Pulp

Yield 1,100 lb.

Character.—Excellent strength and color.

Possible Uses.—Similar to white spruce.

Mechanical Pulp

Yield 1,890 lb.

Character.—Good strength and color, but pitchy.

Possible Uses.—Similar to white spruce.

Poplar, Balsam.—*Populus balsamifera.* Wt. 26 lb. Fiber 1.0 mm.

Range.—Alaska and Valley of Mackenzie River to Hudson Bay and Newfoundland; southward to Northern New England and New York, Central Michigan, and Minnesota, Dakota, Northwestern Nebraska, Northern Montana, Idaho, Oregon, and Nevada.

Sulphite Pulp

Yield 1,300 lb.

Character.—Easily pulped, excellent color, easily bleached.

Possible Uses.—Same as aspen.

Soda Pulp

Yield 1,170 lb.

Character.—Short fiber and soft Easily bleached.

Possible Uses.—Same as aspen.

Redwood.—*Sequoia sempervirens.* Wt. 23 lb. Fiber 5.5 mm.

Range.—From the southern border of Oregon southward in the coast region, 20 to 30 miles inland, through Northern California.

FIG. 62.—Slasher saws which cut 16-foot logs into 32-inch pulpwood.

Sulphite Pulp

Yield 1,100 lb.

Character.—Difficult to bleach. Easily pulped, fair strength, dark colored.

Possible Uses.—Low-grade wrappings.

Sulphate Pulp

Yield 950 lb.

Character.—Long fibered but tender.

Possible Uses.—As a substitute for spruce.

Sassafras.—*Sassafras sassafras.* Wt. 26 lb. Fiber .9 mm.

Range.—Widely scattered throughout the eastern half of the United States.

Sulphite Pulp

Character.—Very difficult to pulp.

Soda Pulp

Yield 780 lb.

Character.—Easily pulped. Difficult to bleach. Short, opaque fiber.

Possible Uses.—Same as aspen.

Spruce, Black.—*Picea mariana.* Wt. 23 lb. Fiber 2.6 mm.

Range.—Newfoundland to Hudson Bay and northwestward to Alaska, southward to Michigan, Wisconsin, Minnesota, and in the eastern mountains to North Carolina and Tennessee.

Sulphite Pulp

Yield 1,050 lb.

Character.—Easily bleached. Easily pulped. Excellent strength and color.

Possible Uses.—Same as white spruce.

Sulphate Pulp

Yield 1,150 lb.

Character and Uses.—Similar to white spruce.

Spruce, Blue.—*Picea parryana.* Wt. 23 lb. Fiber 2.8 mm.

Range.—Central Rocky Mountain region—Colorado, Utah, and Wyoming.

Sulphite Pulp

Yield 1,050 lb.

Character.—Easily bleached. Easily pulped. Excellent strength and color.

Possible Uses.—Same as white spruce.

Sulphate Pulp

Yield 1,150 lb.

Character and Uses.—Similar to white spruce.

Spruce, Engelmann.—*Picea engelmanni.* Wt. 21 lb. Fiber 3 mm.

Range.—Northern Arizona and through the Rocky Mountain region to British Columbia.

Sulphite Pulp

Yield 990 lb.

Character.—Easily bleached. A little hard to pulp—excellent strength. Excellent color.

Possible Uses.—Same as white spruce.

Sulphate Pulp

Yield 1,000 lb.

Character and Possible Uses.—Similar to white spruce.

Mechanical Pulp

Yield 2,100 lb.

Character.—Strong fiber of good color.

Possible Uses.—Same as white spruce.

Spruce, Norway.—*Picea excelsa.* Wt. 30 lb. Fiber ——.

Range.—From the Urals and Lapland to the Pyrenees and Alps.

Sulphite Pulp

Yield 1,350 lb.

Character.—Slightly more difficult to reduce than white spruce. Good strength and color.

Possible Uses.—Same as white spruce.

Sulphate Pulp

Yield —— lb.

Character.—Easily pulped, good strength

Possible Uses.—Same as white spruce.

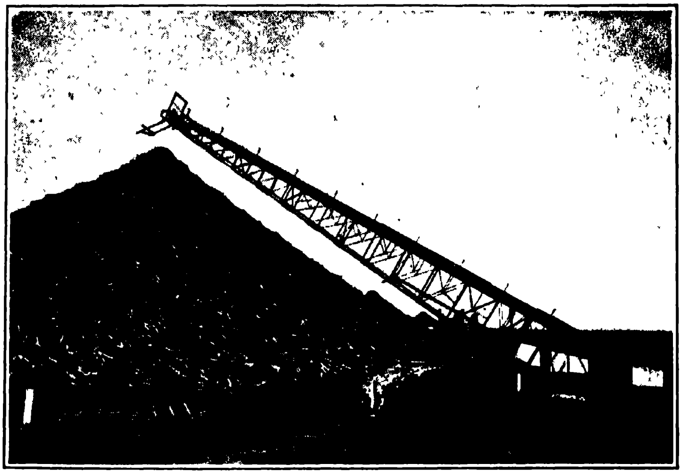


FIG. 63.—A pulpwood stacker.

Mechanical Pulp

Yield 2,400 lb.

Character.—Excellent color and strength.

Possible Uses.—Similar to white spruce.

Spruce, Sitka.—*Picea sitchensis.* Wt. 24 lb. Fiber 3.5 mm.

Range.—Coast region (extending inland about 50 miles) from Alaska to Northern California.

Sulphite Pulp

Yield 1,080 lb.

Character.—Easily bleached. Easily pulped. Excellent strength and color.

Possible Uses.—Same as white spruce.

Sulphate Pulp

Yield 1,150 lb.

Character and Uses.—Similar to white spruce.

Mechanical Pulp

Yield 2,040 lb.

Character.—Slightly grayish color.

Possible Uses.—Similar to white spruce.

Spruce, White.—*Picea canadensis.* Wt. 24 lb. Fiber 2.8 mm.

Range.—Newfoundland to Hudson Bay and northwestward to Alaska; southward to Northern New York, Michigan, Wisconsin, Minnesota, South Dakota, Montana and British Columbia.

Sulphite Pulp

Yield 1,030 lb.

Character.—Easily bleached. Easily pulped. Excellent strength. Excellent color.

Possible Uses.—White spruce is considered the standard sulphite pulpwood and is used for news, wrapping, book, high-grade printings, etc.

Mechanical Pulp

Yield 2,400 lb.

Character.—Excellent color and strength.

Possible Uses.—For practically every purpose where groundwood pulp is required.

Sycamore.—*Platanus occidentalis.* Wt. 29 lb. Fiber 1.7 mm.

Range.—Southeastern New Hampshire and Southern Maine to Northern Vermont and Lake Ontario; west to Eastern Nebraska and Kansas; south to Northern Florida, Central Alabama, Mississippi, and Texas.

Sulphite Pulp

Yield 1,300 lb.

Character.—Soft, easily bleached.

Possible Uses.—Similar to aspen.

Soda Pulp

Yield 1,300 lb.

Character.—Soft, easily bleached.

Possible Uses.—Similar to aspen.

Tamarack.—*Larix laricina.* Wt. 31 lb. Fiber 2.6 mm.

Range.—From Newfoundland and Labrador to Northern Pennsylvania, Northern Indiana, Illinois, Minnesota, and northwestward to the Mackenzie Valley.

Sulphite Pulp

Yield 1,270 lb.

Character.—Difficult to bleach. Difficult to pulp, good strength, poor color.

Possible Uses.—Low-grade wrappings.

Sulphate Pulp

Yield 1,400 lb.

Character.—Strong, tough pulp.

Possible Uses.—Similar to white spruce.

Mechanical Pulp

Yield 2,620 lb.

Character.—Short fibered and gray color.

Possible Uses.—As a substitute for white spruce.

Tulip Tree, Yellow Poplar.—*Liriodendron tulipifera.* Wt. 26 lb. Fiber 1.8 mm.

Range.—From Rhode Island to Southwestern Vermont and west to Lake Michigan; south to Florida, Southern Alabama, and Mississippi, west of Mississippi River in Southeastern Missouri and adjacent Arkansas.

Sulphite Pulp

Yield 1,170 lb.

Character.—Easily pulped, poor color, difficult to bleach.

Possible Uses.—As a substitute for aspen.

Soda Pulp

Yield 1,150 lb. Soft and easily bleached.

Possible Uses.—Same as aspen.

Willow, Black.—*Salix nigra.* Wt. 21 lb. Fiber 0.8 mm.

Range.—New Brunswick to Southern Florida and west to Eastern Dakota, Nebraska, Kansas, Oklahoma, Southern Arizona, and south into Mexico; in California from the Sierra Nevada to Colusa County and Sacramento River.

Sulphite Pulp

Yield 1,100 lb.

Character.—Easily bleached. Easily pulped. Very weak. Excellent color.

Possible Uses.—Same as aspen.

Soda Pulp

Yield 950 lb.

Character.—Soft and easily bleached.

Possible Uses.—Similar to aspen.

Willow, Longleaf.—*Salix fluviatilis.* Wt. 23 lb. Fiber .7 mm.

Range.—Quebec and southward through Western New England to the Potomac River; northwestward to the Arctic Circle, British Columbia and California; southward to Northern Mexico and Lower California.

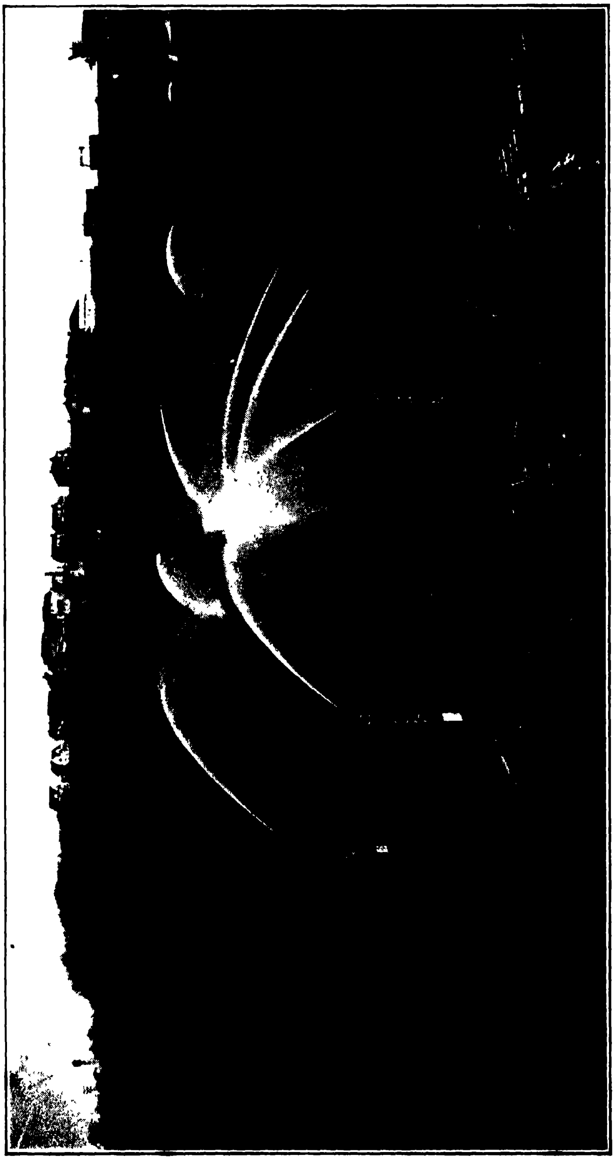


FIG. 64.—Spraying a pile of pulpwood to reduce the fire hazard.

Sulphite Pulp

Yield 1,100 lb.

Character.—Easily pulped and bleached. Very weak and poor color.

Possible Uses.—Same as aspen.

Soda Pulp

Yield 1,030 lb.

Character.—Easily pulped. Rather difficult to bleach. Soft opaque and short fiber.

Possible Uses.—Same as aspen.

Mechanical Pulp

Possible Uses.—Same as aspen.

Yucca.—*Yucca constricta.* Wt. 18 lb. Fiber ——.

Range.—Southwestern Texas to Southern Arizona; Northern Mexico.

Soda Pulp

Yield 720 lb.

Character.—Readily pulped. Rather difficult to bleach. Short pithy fiber.

Possible Uses.—Few.

FIG. 65.—Fire in the forest.

PART III

TIMBER SUPPLY

CHAPTER IX

FOREST REGIONS

There has always been a great deal of popular misinformation as to the timber supply of North America.

On the one hand, we were once told that the forests of the United States—and even more so those of Canada—were inexhaustible, and that Nature left to herself would continue to supply wood for every need.

On the other hand, there has been an increasing volume of public statement for the last generation calling attention to the heavy inroads made upon our forest resources by cutting, fire, storm, insects and fungi and predicting a timber famine within a short time.

As usually happens, both optimist and pessimist have overstated their cases. The true situation is neither so optimistic as viewed by the one nor so pessimistic as seen by the other. But the pessimist may lead us less seriously astray, since it is better to fear the worst and take some measure of precaution against disaster than to anticipate a perpetual bounty which can never be realized.

We can say with some assurance of certainty that the quantity of timber now standing in North America is not more than half the original supply—and that of the half which has disappeared, fully as much has been destroyed by fire as has served any useful purpose. Moreover, the bulk of this half of the forest resources with which the Continent was endowed has gone within the past 50 years—and depletion is still going ahead rapidly. Fires still rage and cutting still goes on to supply the public demand for the wide variety of forest products that cheap and abundant timber has taught us to regard as necessary.

The pessimist notes the great volume of wood cut every

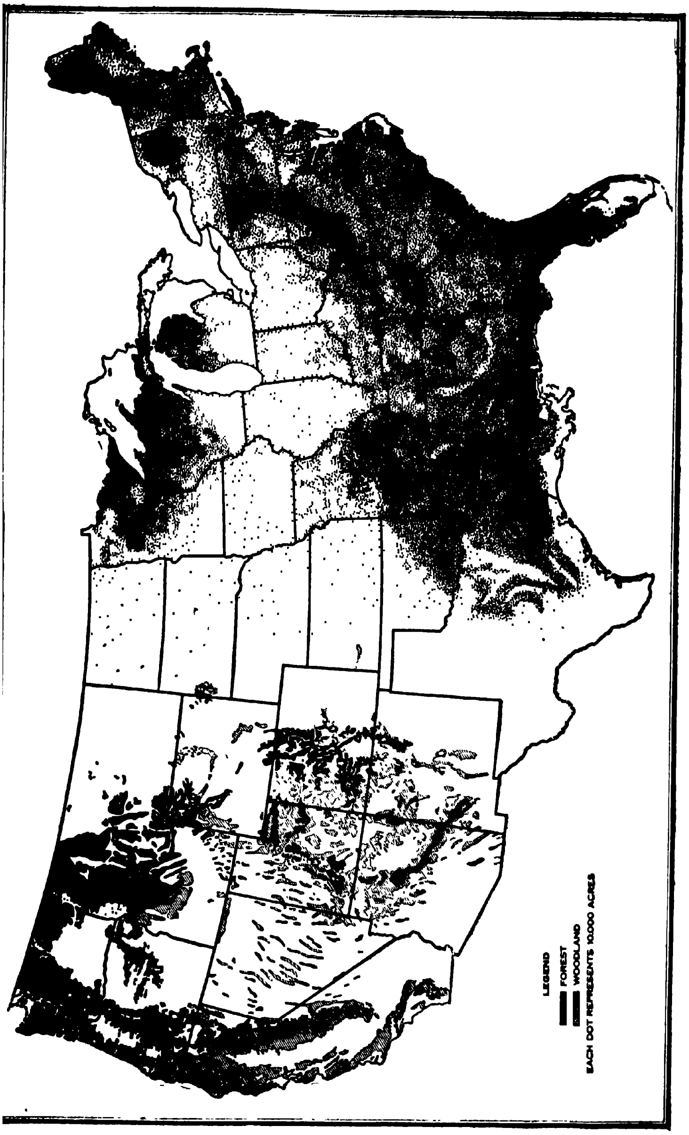


FIG. 66.—Forest and woodland in the United States.

year, the millions of acres of once productive land devastated by fire, and is certain that the end is near.

The optimist sees old New England still supplying large amounts of lumber and pulpwood long after nearly all her virgin forest is gone, he looks at abandoned fields thickly set by nature with thrifty young pines and heavy yields of cordwood cut generation after generation from the same land and he thinks that the situation isn't so bad after all. In the South, pine comes on rapidly, and on the West Coast redwood and Douglas fir, with fire prevention after cutting, reproduce more wood fiber per acre per year than grows anywhere else in America.

The situation is serious, and already the pinch of timber shortage has affected many localities and many industries both far and near, but it is by no means hopeless. Accurate data are lacking, but we know the main outlines of the problem of our timber supply and the most important factors in its solution. We will have less timber before we have more, but there is no good reason why the North American Continent should not indefinitely supply all the wood needed by its citizens for every purpose with some balance for export, once we get all our forest land upon a producing basis. The pinch will come in the period between the exhaustion of the greater part of our virgin timber and the coming to harvest of a second crop grown under forestry methods. Stated differently, we may be in worse straits 30 years hence than 60 years after that time. It will be like the time "between hay and grass" which the western stockman is called upon to endure every spring, and for which sometimes he is not fitly prepared.

There are five great forest regions in North America—the Northern, Southern, Central, Rocky Mountain and Pacific Coast, with the first three widely separated, except in the far North, from the last two by the treeless stretches of the Great Plains. (See Frontispiece). There is much overlapping of types and mixture of species, but the chief characteristics of the forest growth in each of these regions are clearly distinguishable.

The Northern Forest.—The Northern forest, confined to the higher elevations along the Southern Appalachians, widens out to cover New York, New England, the Lake States and Canada east of the prairie provinces. It was originally a region in which the conifers greatly predominated and where the white and red pine, the red and white spruce, balsam fir, hemlock, white cedar, tamarack and jack pine attained their best development. There were areas in which hardwoods were mixed with conifers, and many splendid stands of beech, birch, maple, elm, ash, basswood, oak, poplar and other species, but white pine and spruce were the foundation of the great lumber industry of the continent, and spruce and poplar the basic material for a later but no less important paper industry.

The original area of this Northern forest in the United States was perhaps 150 million acres with a total stand of all kinds of timber equivalent to 1,000 billion bd. ft. Inadequate as are the estimates of the forest resources of the United States, they are better than the estimates for Canada. It is probable, however, that the original area of merchantable (but not all accessible) forest in the eastern part of the Dominion was not less than 200 million acres with a stand of 600 billion bd. ft. making a combined area of 350 million acres with a stand of 1,600 billion bd. ft. for the Northern forest in the two countries.

Today there is not over 40 per cent as much timber standing in this area as there was when settlement began, and, as noted elsewhere, the bulk of it has gone within the last two generations.

The Southern Forest.—The Southern forest was also predominatingly one of coniferous species—and chiefly the yellow pines, longleaf, shortleaf and loblolly. It covered large portions of the South Atlantic and Gulf States, extending far back into those States and up to Arkansas and Oklahoma. There were also large local areas of cypress, some of cedar and much hardwood in some sections.

The original area of this forest was perhaps 220 million acres with a stand of 1,000 billion bd. ft., of which only 40 per cent is estimated to remain today. The Southern forest has furnished a wealth of structural material and of naval stores but until the recent application of the sulphate process to the yellow pines, it has been little drawn upon for paper-making supplies. A rather rapid development in this respect is predicted for the future because of the present cheapness of yellow pine pulpwood compared with Northern spruce and hemlock.

The Central Hardwood Forest.—The Central forest region of the United States lies between the Northern and Southern, starting on the Atlantic Coast and expanding westward to the prairie states. It is primarily a hardwood forest and has no counterpart in Canada, as the hardwoods do not thrive so well in the more northern latitudes.

The Central forest region is the home of the finest hardwoods that modern civilization has had available for a multitude of uses. Here it was that oak, ash, beech, walnut, hickory, chestnut, yellow poplar, basswood, cottonwood, sycamore, gum, cherry and other species reached their largest dimensions and heaviest stands, growing in mixtures of the richest profusion. It is no uncommon thing for the hardwood lumberman to have to manufacture as many as 20 distinct species of timber, each with its own qualities, grades and sizes, while the uses to which these products are put in the arts and industries mount literally into hundreds and hundreds.

This forest supplied little pulpwood except the true poplars (cottonwood and aspen) until the soda process was turned to the gums, yellow poplar (tulip-tree) and other hardwoods with increasing use of these species as noted elsewhere.

The Central hardwood forest is the most difficult of all types to estimate either as to original or present areas and

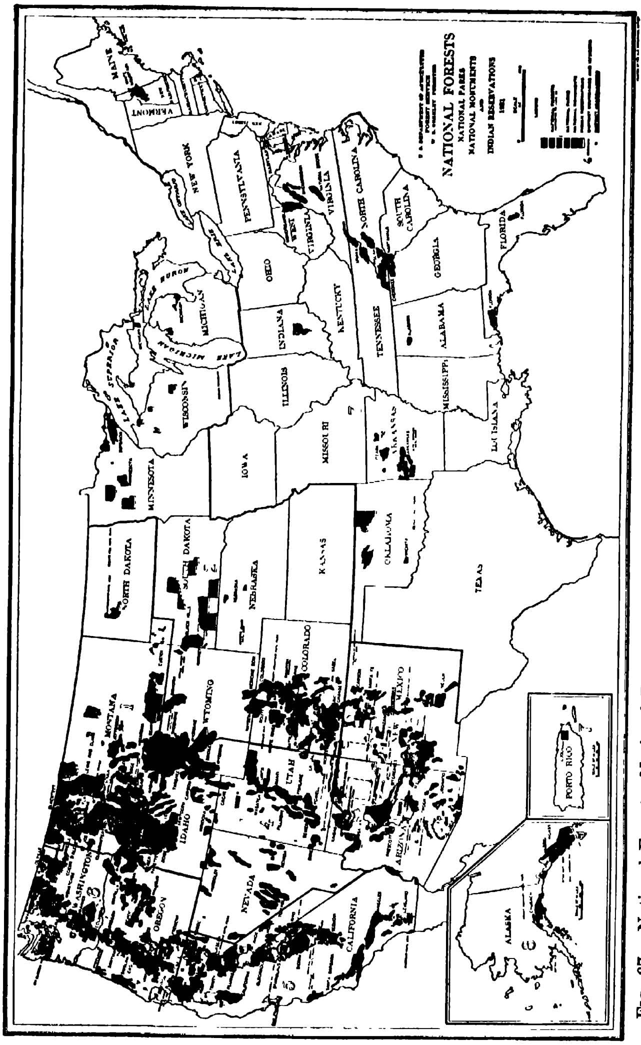


FIG. 67.—National Forests, National Parks, National Monuments and Indian Reservations in the United States.

stands. It may once have covered as much as 280 million acres with a stumpage equivalent to 1,400 billion bd. ft. while now it is doubtful if the stand is more than 250 billion ft.

While this type of forest has not been subject to as devastating fires as the northern and western coniferous forests, it occupied much of the richest agricultural land of the continent, so that clearing for early settlement took heavy toll of nature's bounty. This is the region of the typical farm woodlot, which while in every way a desirable farm adjunct, often represents but a heavily culled, neglected fragment of the original forest.

The Rocky Mountain Forest.—The Rocky Mountain type of forest, found only on the higher elevations in the arid southwest, comes to lower elevations as we go northward and is the prevailing type in Canada west of the Plains except for the Coast type in British Columbia.

This is entirely a coniferous forest so far as practical uses are concerned except for occasional stands of the poplar family or, in the north, white birch. It contains more Western yellow pine than all other species combined and this is the only one of much commercial importance in the more southerly portion. Further to the north there are also spruce, Douglas and white fir, lodgepole pine, larch, Western hemlock, Western red cedar and Western white pine.

Due to the frequent occurrence of long dry seasons, the rugged topography and the sparseness of population, fire has done tremendous damage throughout the Rocky Mountain region and the quantity of timber so destroyed is many times in excess of that which has been cut and put to any useful purpose. The story is the same whether one views the fire-swept mountain slopes and plateaus of Colorado, the great barrens caused by fire in the interior of British Columbia or the hundreds of miles of killed timber along the Yukon river.

Such estimates as have been made indicate an original area of 110 million acres and a stand of 400 billion ft. for the Rocky Mountain forest in the United States, with a stand of 220 billion ft. remaining at this time. Canadian data make it a reasonable assumption that this type of forest in British Columbia once covered 80 million acres, but hundreds of billions of feet of timber have been destroyed by fire so that the stand is now reduced to about 136 billion ft., making a present estimated stand of 356 billion feet in the Rocky Mountain forest of North America.

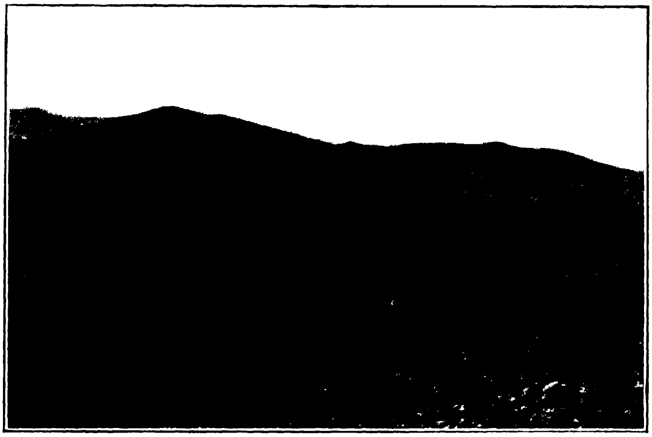


FIG. 68.—The tundra country in Alaska. This is characteristic of the Arctic slopes of North America.

The principal utilization of this forest so far has been for lumber, poles and railroad ties. There are a number of localities suitable for the manufacture of pulp and paper in respect to wood supply and possibility of waterpower development, but such locations are a long distance from points of consumption which are generally now supplied with paper products on competitive freight rates from well-established operations in other regions.

There is only one paper mill of any consequence in the entire Rocky Mountain region. This is near Spokane, Washington, and uses about 30,000 cords of wood yearly in the production of news-print paper. Some of the pulpwood used in this mill is brought by rail from points more than 150 miles distant.

A recently built board mill in Denver is reported to use some wood cut within 30 or 40 miles of that city.

The Pacific Forest.—The Pacific Coast type of forest, while not so large in area as some other types, contains some of the most useful species, and by far the largest trees and densest growth of wood per acre known anywhere in the world. There are a few localities with a small amount of merchantable hardwoods, but these are insignificant in comparison with the magnificent stands of pine, fir, redwood, spruce, hemlock and cedar.

Lying to the west of the Rocky Mountain region, this type of forest attains its perfection in Pacific drainage areas of California, Oregon, Washington, British Columbia and Southeastern Alaska. Its total original area in the United States was perhaps 90 million acres with a stand of 1,400 billion bd. ft. and in British Columbia 15 million acres with 300 billion ft. of stumpage. Today there is said to be about 1,130 billion ft. of merchantable timber of this type in the United States, some 230 billion ft. in British Columbia and in the neighborhood of 80 billion ft. in Southeastern Alaska, which is not far from the original amount in the latter region as little cutting has yet been done. It is somewhere near the truth to say that in the Pacific Coast type of forest from California to Alaska, there is now standing 1,440 billion bd. ft. of merchantable timber according to present standards of utilization or half of the saw timber supply of North America north of the Rio Grande.

Fire has done great damage in some portions of this region, but not so universally as in the Rocky Mountain area. Northward along the Coast the fire hazard becomes materially less with increasing summer precipitation. It is claimed that 30 per cent of the original Douglas fir area in Oregon and Washington has been devastated by forest fires.

The Pacific Coast has long been an important source of supply for structural materials in wood and is destined to much greater development in this respect with the progressive cutting out of the virgin stands of eastern and southern timber.

The manufacture of pulp and paper has also attained considerable volume on the Pacific Coast with the past 15 or 20 years, supplying most of the home market and an important export trade. Expansion of this industry is not so much a question of raw materials and waterpower as of prices, freight rates and markets.

LIBRARY
21 JUL 1924

CHAPTER X

WHAT WE HAVE

In the United States.—Any approach to a flat statement as to the forest area and the quantity of timber yet standing in North America must be made with many reservations and qualifications. A tree census is not possible and such estimates as we have are compilations from scattered and too often fragmentary data, pieced together with some skill to make an inadequate picture of the situation. The total land area of North America is easily computed from extensive surveys and accurately determined geographical points. We also know with a reasonable degree of accuracy the quantity of timber cut in various forms and at different

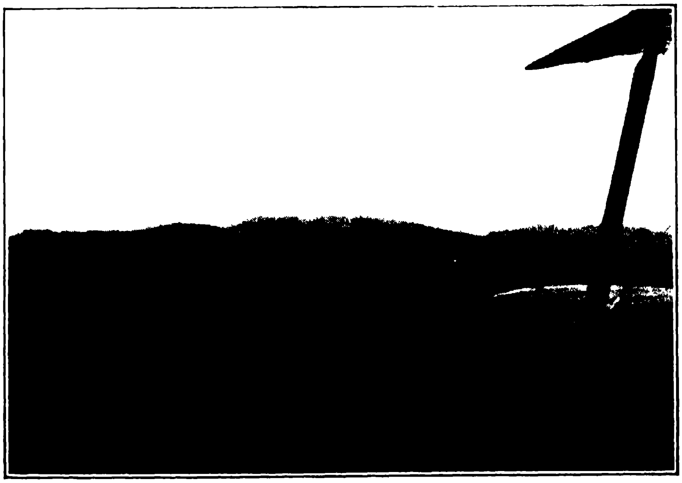


Fig. 69.—Typical forest on the west slope of the Cascades in Central Oregon. Timber mostly Douglas fir.

times in the past, so calculations of total cut are feasible. But the charting of our forest-fire losses and the measurement of our remaining timber stand with respect to species, quantity and quality will not be done with exactitude for many years to come.

However, some taking account of stock is necessary and in the absence of a complete inventory of the forest resources of North America, the most reasonable estimates serve a useful purpose. Such considerations must be borne in mind in reading the figures contained in this book. Few of them are original with the author, nor are they with any other one individual, but he hopes to present data whose errors are on the side of conservatism.

Saw Timber.—The total present stand of saw timber in the United States is estimated to be 2,200 billion bd. ft. on an area of 250 million acres in addition to which there is about 130 million acres carrying a cordwood stand of some value and 80 million acres of potential forest land which has been so severely cut and burned that nature unaided will not be able to produce a commercial timber crop upon it within a reasonable period of time.

Summing up the available data we get the following:

ESTIMATED STANDS OF MERCHANTABLE SAW TIMBER IN THE UNITED STATES

Forest Regions	Billion board feet	
	Original	Present
Northern	1,000	200
Southern	1,000	500
Central	1,400	150
Rocky Mountain	400	220
Pacific Coast	1,400	1,130
Total	5,200	2,200

Stated in other fashion, nearly 60 per cent of the merchantable saw timber of the United States has been utilized or destroyed and the bulk of it has gone in the past 50 years.

Hardwoods.—It is far more difficult to make an estimate of the quantities of the respective hardwoods than of the total stand since there are so many degrees of mixture. The Forest Service estimate of merchantable hardwoods in the eastern United States is approximately as follows:

Species	Billion board feet	Species	Billion board feet
Oak	157	Ash	10
Birch, beech and maple	91	Yellow poplar	10
Red gum	44	Others	102
Chestnut	19		
Hickory	16	Total	460
Cottonwood and aspen	11		

The oaks are among the most widely distributed hardwoods, but practically half of the total stand is credited to the South Atlantic and Gulf States and about 40 per cent to the Central States. Most of the birch, beech and maple is in the Central and Lake States. The heaviest stands of red gum are in the lower Mississippi region with a considerable proportion in the South Atlantic States. Because of the chestnut blight, that valuable species has been destroyed in the northern part of its range and the disease is spreading fatefully to all sections where the chestnut has been an important timber tree. Cottonwood and aspen, excellent woods for paper making through the soda process, are seldom found in heavy stands. Most of the aspen is in New England and the Lake States, while cottonwood is most abundant in the valleys of the Mississippi and its tributaries.

Taking all the eastern hardwoods together, 29 per cent of the total estimated stand is in the Central States, an equal amount in the lower Mississippi region, 18 per cent in the South Atlantic and east Gulf States, 15 per cent in the Lake States and the balance of 9 per cent in the Middle Atlantic and New England States.

Softwoods.—The stand of saw timber of eastern softwoods is estimated at 380 billion bd. ft. as follows:

Species	Billion board feet	Species	Billion board feet
Southern yellow pine ...	250	White and Norway pine	22
Hemlock	30	Other .	26
Spruce and fir	30		
Cypress .	22	Total . .	380

As is generally known, the southern yellow pines and cypress characterize the South Atlantic and Gulf States, hemlock and white pine are chiefly in New England and the Lake States, and more than 87 per cent of the spruce and fir in New York and New England.

The western softwoods in the United States are assumed to total about as follows:

Species	Billion board feet	Species	Billion board feet
Douglas fir....	590	Western red cedar.....	53
Western yellow pines	250	Lodgepole pine	44
Western hemlock	95	Spruces	40
True firs.. . .	90	Other . . .	69
Redwood.. . . .	72		
Western white and sugar pine...	57	Total	1,360

All of these species except redwood are found to some extent in the Rocky Mountain as well as the Pacific Coast region. Lodgepole pine and the spruces occur in materially larger quantities in the Rocky Mountain region than on the Coast and about one-third of the total stand of western yellow pine is in the former area. Altogether, however, but 16 per cent of the total stand of western softwoods is in the Rocky Mountain forest types with the balance in the Pacific Coast region.

Douglas fir is by far the most important timber species in the United States today. It will be noted that the present stand of this species alone is more than double the combined total of the several Southern yellow pines. In fact, it is equal to twice the Southern pine stand plus all the eastern hemlock, spruce, fir, white and Norway pine. In addition, Douglas fir is the leading species in British Columbia, where the estimated stumpage is not less than 76 billion bd. ft. Douglas fir occurs widely through the Rocky Mountain region, but the best development is reached west of the Cascades in Oregon and Washington and more than 85 per cent of the total stand in the United States is in these two states.

FIG. 70.—Typical upland country in Labrador.

The western pines are valuable lumber species but never likely to be much used for pulp, nor are redwood and western red cedar, two uniquely valuable species for a wide variety of purposes and especially where durability is required.

The western hemlock, the true firs and the spruces, now furnish the chief pulpwood supply for the Pacific Coast sulphite and groundwood mills, while Douglas fir is used for sulphate pulp. At the same time, the hemlock and spruce are regularly manufactured into lumber, as are the related eastern species. Washington and Oregon are now the largest lumber producing states in the Union and will remain so for many years to come.

In Canada.—Even more than in the United States, satisfactory data are lacking in Canada upon the quantity and quality of the species which make up the forest resources of the Dominion. Nevertheless, it is necessary to use such figures as may be available, remembering that they are subject to rather wide revision as time goes on.

A recently published estimate upon the total timber supply in Canada is as follows:

Region	Billion board feet		Total
	Softwoods	Hardwoods	
Eastern provinces	300	100	400
Prairie provinces	140	85	225
British Columbia	360	2	362
Total	800	187	987

It is also estimated that of this total stand, equivalent to 987 billion bd. ft., 560 billion bd. ft. or 57 per cent is of saw timber size. The latter figure substantially corresponds to the estimate of the total volume of saw timber in Canada that has been current for the past 20 years.

Estimates as to the total extent of the forests of Canada are especially difficult because of the extensive regions which are on the border line between forest and barren land. It seems a fair assumption, however, that the nonagricultural area capable of producing some kind of forest amounts to nearly one million square miles or about 600 million acres, and that 50 per cent of this area or 300 million acres now carries a merchantable stand of saw timber or pulpwood. More than half of the total land area of the Dominion is classified as having no value at this time for either agriculture or timber.

The latest estimates of the forest areas and timber stands of Canada are those prepared by the Dominion Forestry Branch for the Empire Forestry Conference in August, 1923, and made available after the text of this book was in type. The unit of volume in these estimates is the cubic foot, and it is calculated that 219 cu. ft. of standing timber is equivalent to 1,000 bd. ft.; that 117 cu. ft. of pulpwood is equivalent to one cord, and that 95 cu. ft. of hardwoods is equivalent to one cord of fuelwood. These estimates are summarized in the following tables.

It is especially to be borne in mind that there is a great deal of timber in both Canada and the United States which, notwithstanding fair quality and stand, is wholly inacces-

Classification of Land Surface of Canada (Square Miles)

	Agricultural land	Forest			Other land	Total area
		Merchantable	Unprofitable or inaccessible	Total		
Prince Edward Island	1,700	300		300	184	2,184
Nova Scotia	3,600	2,900	8,475	11,375	6,093	21,068
New Brunswick	6,000	15,000	3,750	18,750	3,161	27,911
Quebec...	40,000	200,000	300,000	500,000	150,865	690,865
Ontario	60,000	75,000	165,000	240,000	65,880	365,880
Manitoba	57,300	27,600	110,000	137,600	37,026	231,926
Saskatchewan...	113,000	25,000	25,000	50,000	79,808	242,808
British Columbia..	20,700	50,000	100,000	150,000	182,716	353,416
Alberta	120,400	60,000	17,900	77,900	45,625	252,925
Territories..		1,000	9,000	10,000	1,404,353	1,414,353
Total.	431,700	456,800	739,125	1,195,925	1,975,711	3,603,336
Per cent of total land....	12	13	20	33	55	100

ESTIMATED STAND OF TIMBER OF MERCHANTABLE SIZE IN CANADA (1,000 cu. ft.)

Species	Saw material	Pulpwood, fuelwood, ties, poles, posts, etc.	Total
Softwood			
Spruce	25,264,715	44,783,154	70,047,869
Balsam	10,516,820	19,203,440	29,720,260
Jack pine	3,996,530	25,254,492	29,251,022
Cedar	17,979,240	4,065,761	22,045,001
Douglas fir	16,512,600	374,400	16,887,000
Hemlock	14,879 518	1,265,136	16,144,654
White pine	3,827,025	4,559,958	8,386,983
Red pine	866,145	1,632,735	2,498,880
Larch	732,115	710,184	1,442,299
Western yellow pine	876,000	117,000	993,000
Yellow cypress	876,000	117,000	993,000
Total	96,326,708	102,083,260	198,409,968
Hardwood			
Poplar	3,234,630	26,315,480	29,550,110
White birch	1,188,045	5,599,100	6,787,145
Yellow birch	2,278,695	3,003,550	5,282,245
Maple	1,359,114	2,671,125	4,030,240
Beech	401,979	741,734	1,143,713
Basswood	242,214	302,100	544,314
Elm	195,786	235,298	431,083
Ash	120,669	213,250	333,919
Cottonwood	172,572	....	172,572
Oak	43,143	58,330	101,473
Alder	....	4,750	4,750
Total	9,236,847	39,144,717	48,381,564
Grand total	105,563,555	141,227,977	246,791,532

sible at the present time. Logging is a question of costs and transportation, and with increasing timber values forest areas are continually being opened up that heretofore have been considered unprofitable to operate. We may say with certainty that a particular stand of timber is inaccessible

Estimate of the Total Pulpwood Resources of Canada (1,000 cu. ft.)

	Spruce	Balsam	Hemlock	Jack pine	Poplar	Total
Eastern provinces	37,532,369	21,120,835	1,402,126	5,999,372	10,457,210	76,511,912
Prairie provinces . . .	14,773,500	713,925		19,497,450	18,902,900	53,887,775
British Columbia.	17,742,000	7,885,500	14,742,520	3,754,200	190,000	44,314,228
Total	70,047,869	29,720,260	16,144,654	29,251,022	29,550,110	174,713,915
Equivalent in cords (117 cu. ft.)	598,699,735	254,019,316	137,988,496	250,008,735	252,565,043	1,493,281,325

today, but it may not be said with any certainty at all that the time will not come when means will be found to utilize it.

Other current estimates for the various Canadian provinces run as follows:

Quebec.—The Province of Quebec, including Ungava, has an area of 735,000 sq. mi. or some 470 million acres, of which nearly 60 per cent is classified as barren and of little present economic value. This is especially true of the immense territory lying between the Labrador Coast and Hudson Bay. The forest area of the province is approximately 25 per cent of the total.

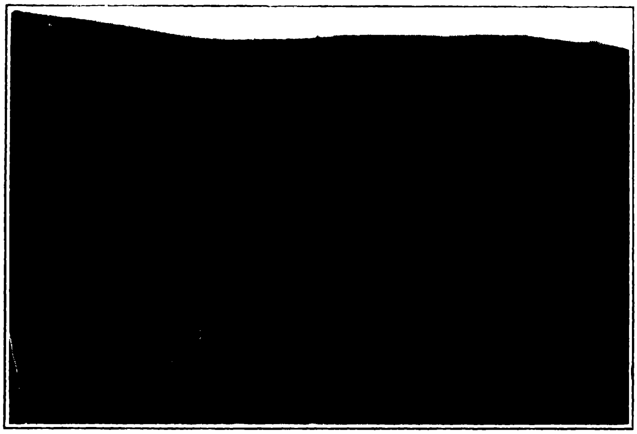


FIG. 71.—Black spruce at timber line on a mountain slope near the Arctic Circle.

Quebec is by far the most important province in Canada in present output of forest products and probably contains more than half the timber supply of the Eastern part of the Dominion. A few years ago the Provincial Forester estimated the total stand of pulpwood timber (spruce, balsam, poplar and jack pine) at 360 million cords on 126 million acres taking everything down to a diameter of 4 in. This total was arrived at by estimating an average of 4 cords per acre or 180 million cords on the 45 million acres of Crown lands under license, 2 cords per acre or 150 million cords on the 75 million acres of unlicensed Crown lands, and 5 cords per acre or 30 million cords on 6 million acres of privately owned forest land. As to how much of this timber, particularly on the unlicensed Crown lands, is of sufficient density and accessibility to warrant logging operations is matter for large difference of opinion. Some students of the problem maintain that less than half of the estimated total of 360 million cords of pulpwood in Quebec can really be considered as available for pulp manufacture according to present standards. Neither do we yet know with any accuracy the total of the large quantity of balsam and spruce that has been partially or wholly killed by the budworm in the past 10 years, nor what proportion of this damaged timber may be made into pulp before it is destroyed by decay, insects or fire.

Were there to be no increase over the present rate in the cut of softwoods for pulp and lumber in Quebec, and were all the estimated stand of 360 million cords accessible, the supply would last for 100 years if it were not reduced by fire, storms or insects. On the other hand, much publicity has been given to a statement that the available supply of timber in eastern Canada will be exhausted in 10 years. It is sufficiently obvious that neither of these conditions will occur.

The most recent estimate of the forest resources of Quebec in spruce, balsam and jack pine according to natural divisions is:

Quebec	Cords
St. Lawrence Valley	185,000,000
James Bay Slope	75,000,000
Ungava, Labrador and Hudson Bay	20,000,000
Total	280,000,000

In addition to the foregoing, there is said to be 2¾ billion bd. ft. of pine, 5 billion bd. ft. of hardwoods and 35 million cords of poplar in the St. Lawrence and James Bay areas. Putting these species together under a common denominator gives an equivalent of 165 billion bd. ft. of timber on an estimated area of 118 million acres. This is at the rate of 1,400 bd. ft. or less than 3 cords per acre for the entire area.

Ontario.—Forest surveys and studies of conditions in Ontario have not yet progressed far enough to permit a very definite statement as to areas and stands. One estimate is that the total forest area amounts to about 80 million acres or 34 per cent of the land area of the Province and that the entire timber stand is equivalent to 186 billion bd. ft., which is at the rate of 2,300 bd. ft. or 4½ cords per acre. While the bulk of the timber is of pulpwood character, there is also a considerable quantity of white and red pine, hemlock and various hardwoods.

Quite naturally more attention has been given to the question of pulpwood than to any other aspect of the Ontario forests. The official estimate in this respect, made a few years ago, was a total of 250 million cords of spruce and balsam of which 25 million cords were said to be on privately owned lands, 85 million cords on licensed Crown lands and 140 million cords on unlicensed Crown lands. There is no certainty as to just what proportion of this total stand may be commercially accessible, since much depends upon future railroad building. However, it is probable that the ratio of accessibility will prove materially higher in Ontario than in Quebec.

A typical advertisement for the sale of Crown land timber in Ontario is reproduced on page 251.

New Brunswick.—The total forest area of New Brunswick is about 13 million acres with a stand of some 30 billion bd. ft., or an average of about 2,500 feet per acre. Spruce and balsam are the most important woods and the estimated total stumpage of these species is 36 million cords, making an average pulpwood stand of approximately 3 cords per acre. It is assumed in the foregoing estimate that 20 million of the 36 million cords is on some 6 million acres of licensed Crown lands, 12 million cords on 4½ million acres of privately owned lands and 4 million cords on 2½ million acres of settlement lands. Practically all of the Crown lands in the Province are under license.

The budworm has done much damage in New Brunswick, and in addition the ratio of total cut to total stand is higher than in any other Canadian Province.

Nova Scotia.—The timberland in Nova Scotia is practically all in private ownership. There has been heavy cutting on the mainland and much damage from fire. There is said to be a large amount of spruce and balsam on Cape Breton Island which it has not yet seemed profitable to operate.

The estimated stand of spruce and balsam for the entire province is 25 million cords. The pulpwood cut is small in proportion to the total stand and is chiefly manufactured into groundwood for export.

Newfoundland.—Although politically not part of the Dominion of Canada, Newfoundland geographically should be considered in connection with New Brunswick and Nova Scotia.

There are no adequate reports upon the forest area of the island nor upon the quantity of standing timber. Much of the land surface is very rough and barren but there are numerous coves and valleys in which excellent stands of spruce are found.

There is one large paper mill in Newfoundland, with a capacity of 200 tons of news print daily, which ships its product to English newspapers under the same ownership and a current project for a much larger mill on the part of other capitalists. Should the latter materialize it is likely that these two mills would require the principal part of the available pulpwood of the island.

The coast region of the Labrador peninsula is a dependency of Newfoundland. There is a considerable quantity of pulpwood timber along the bays and inlets, but no authentic information is available as to the total stand nor the extent to which it can be profitably utilized.

The Prairie Provinces.—The three Canadian Prairie Provinces—Manitoba, Saskatchewan and Alberta—are estimated to have the equivalent of 225 billion bd. ft. of timber, of which 77 billion are jack pine, 74 billion poplar and 60 billion spruce and balsam. These potential pulpwoods thus make up 94 per cent of the total, but because of the many scattered and inaccessible stands, the distance from market and other economic factors, it is not likely that the manufacture of pulp and paper will ever become of great importance in this region.

British Columbia.—British Columbia is large in area and includes a striking range of topography, climate and resources. The temperature varies from the southwestern Coast where a hard freeze seldom occurs to regions of perpetual glaciers and winters of Arctic severity; there are numberless mountain ranges and massive peaks, an almost arid condition in parts of the interior and a yearly precipitation of 100 in. in some parts of the Coast. The Coast Range runs up to 10,000 ft. in elevation, while in the interior there are 100 peaks exceeding 10,000 ft. in height. Some of the finest forests of Douglas fir, Sitka spruce and Western red cedar to be found on the Continent grow in the warm and humid Coast region near sea level, while in the interior there are vast areas above timber line.

A more thorough job of estimating the forest resources of British Columbia has been done than perhaps for any other extensive political subdivision of North America. The area of the province is 355,855 sq. mi. or nearly 288 million acres. Of this total, however, it is said that 200,000 sq. mi., or 56 per cent is incapable of producing forests of commercial value; that 145,000 sq. mi. or 40 per cent of the area of the whole Province lies above merchantable timber line and that 55,000 sq. mi. has soil so rocky or so completely destroyed by fire that natural regrowth of timber is impossible. It is calculated that 38 per cent of the area of the Province or about 87 million acres is land of a character which should be permanently kept growing timber and that only 6 per cent is potential agricultural soil.

It is estimated that the timber on areas totaling 100,000 sq. mi. or two-thirds of the original forest cover of the Province has been totally destroyed by fire and half of the remainder seriously damaged. A large proportion of this fire damage, of course, has been in the interior where long dry seasons are of frequent occurrence.

FIG. 72.—A typical interior Alaskan scene—both as to mining and timber. Small black spruce in the foreground and fire-killed white birch and poplar in the background.

Notwithstanding all this, there is more timber of saw size in British Columbia than in all the rest of the Dominion combined.

According to legal definition, there are 28,000 sq. mi. or nearly 18 million acres of "statutory timberland" in British Columbia, this meaning a stand of 8,000 bd. ft. or more per acre west of the Coast range and of 5,000 bd. ft. or more east of that range.

The total stand of saw timber in the Province is estimated at 351 billion bd. ft. of which 214 billion bd. ft. or 61 per cent is in the Coast district and 137 billion bd. ft. in the interior. In addition to the saw timber, there is also in the Coast region the equivalent of 15 billion bd. ft. of piling, poles and pulpwood timber.

Two-thirds of all the stumpage in British Columbia is composed in nearly equal proportions of three species—Western red cedar, Douglas fir and spruce, although strictly speaking, two or three kinds of spruce enter into the totals grouped under that name. Western hemlock and white fir make up 28 per cent of the total saw timber in the Province, with the remaining 7 per cent distributed among half a dozen species of which lodgepole pine is most important with lesser amounts of Western yellow pine, Western white pine, yellow cypress and larch.

Of the species commonly used for pulp—spruce, hemlock, white fir and cottonwood—there is a stand of about 255 million cords. The converting factor used in British Columbia is 700 bd. ft. to the cord.

The Coast forests, of course, are much heavier than those of the interior, and with the exception of spruce, the largest proportion of the most valuable species is in the Coast region. Seventy-seven per cent of the western red cedar, 83 per cent of the Douglas fir, 81 per cent of the western hemlock and 58 per cent of the white fir are in the Coast district. On the other hand, 80 per cent of the spruce and practically all the lodgepole, Western yellow and Western white pine are in the interior of the Province.

The most important forest type in British Columbia from the pulpwood standpoint is the hemlock-Sitka spruce type which is usually found at elevations of less than 500 ft. This type of forest is estimated to average 38 per cent hemlock, 27 per cent spruce and 11 per cent balsam—all excellent pulpwoods with the balance chiefly red cedar which is the most valuable timber tree on the Coast.

East of the Coast Range in British Columbia the original forest consisted of at least 60 per cent spruce—fir types, made up of combinations of white spruce and alpine fir or Engelmann spruce and alpine fir depending upon latitude and elevation. Fires have been so destructive in this region that in many places only remnants of the original forest types remain, or they have been replaced by lodgepole pine. This species has great reproductive power after fire since the cones may remain closed until the heat opens them and liberates the seeds which make the beginning of a new crop of timber following the one the fire destroyed.

FIG. 73.—A bit of Northern British Columbia near the coast. The lake in the foreground furnishes power for a paper mill.

As elsewhere in Canada, much of the land in British Columbia is in public ownership. The Province controls nearly 212 million acres and the Dominion nearly 14½ million acres in British Columbia, the latter mostly in the C. P. R. belt. Of the estimated 351 billion bd. ft. of saw timber in the Province, 260 billion bd. ft. or 74 per cent has been alienated as follows:

	Billion board feet		Billion board feet
Provincial timber licenses	161	Dominion timber licenses	17
Crown grants	50	Provincial pulp leases	10
Provincial timber leases	22	Total	260

The Total for North America.—In these discussions no reference is made either to the timber supply or the rate of its utilization in Mexico. There is one modern pulp and paper mill in that country which normally uses some 40,000 cords of wood yearly. It is situated at an elevation of about 9,000 ft. not far from Mexico City and uses local timber. There are no accurate estimates of the kinds and quantity of timber for the country as a whole and, under present conditions, little incentive for its utilization.

There is a vast area in Canada and Alaska which is popularly credited with being forested but which so far as we know now can never have any commercial timber of value aside from firewood of small size and poor quality. This is the "muskeg" country with scattered stands of black spruce persisting under such severe climatic conditions that a diameter of 2 or 3 inches may represent the growth of 100 years.

From the Rio Grande and the Gulf of Mexico to the Northern limit of merchantable tree growth in America it would appear that there is a total of some 2,800 billion bd. ft. of saw timber of which 76 per cent is in the United States, 20 per cent in Canada, and 4 per cent in Alaska.

In addition to the saw timber, there is perhaps the equivalent of 1,700 billion bd. ft. of smaller timber variously suited for pulpwood, posts, poles, cross ties and firewood according to species involved.

Of the species which are most largely used for pulp at the present time, there may be the equivalent of 2,000 million cords in North America. But it must be borne in mind that as much as half of this total may be unavailable at present costs and that some of it is likely to be permanently beyond possibility of utilization. It must also be remembered that these same species are heavily drawn upon for other products. Hence any attempt to predict the length of the pulpwood supply by dividing the total of 2,000 million cords by 9 million cords, the present annual consumption, is extremely fallacious.

FIG. 74.—Pulpwood cutting at an elevation of 8,000 feet in a California National Forest.

Neither should any reliance be placed upon statements to the effect that we need not worry about a timber shortage in North America because after the sawtimber and pulpwood is mostly cut in the United States and Canada, we can draw upon the vast, untouched forests of Russia, Siberia and the tropics for our necessary supplies of lumber and wood pulp.

The plain unvarnished truth is that we must produce at home the great bulk of the wood we want or get along as best we may without it.

The only correct approach to this problem is to take up in turn each principal wood-using district, analyze the situation with respect to stand and possible growth in its tributary timber supply, and note the probable future development therein.

CHAPTER XI

FOREST OWNERSHIP

In the United States.—Of the 460 million acres of forest land in the United States, 98 million acres or 21 per cent is in some form of public ownership, *i.e.*, Federal, state or municipal, and of the estimated total stand of 2,200 billion bd. ft. of saw timber nearly 660 billion bd. ft. or 30 per cent is publicly owned.

Prior to 32 years ago, the settled policy from the time of the adoption of the Federal Constitution was to dispose of the public lands as rapidly as possible on the theory that private ownership of all natural resources was desirable, and the best means of promoting material progress. Under this plan, the rich agricultural region of the Middle West was homesteaded by settlers, practically as large an area, including both timbered and farm land, was patented to corporations to encourage transcontinental railroad building as was granted in homestead and other settlement acts, large amounts of timberland were sold at from $1.25 to $2.50 per acre and 100 million acres of the public domain was given to the states to encourage education and for other purposes.

This process of distributing the public lands went on until 1891 and very naturally most of the land which up to that time was regarded as most valuable went into some form of private or corporate ownership. Many who in later days have railed against the dissipation of the public domain overlook the fact that such was the accepted National policy for a century.

Gradually, however, there grew up an intelligent and influential body of opinion to the effect that public ownership of a certain amount of timberland is essential to the future welfare of the country and in 1891 Congress passed an act empowering the President to withdraw from entry or sale public lands which were wholly or in part covered with timber or undergrowth. This was the beginning of the National Forests, as they are known today, and the most important single step ever taken in the protection of the forest resources of the United States. The public lands available for the creation of forest reserves under this plan were almost entirely in the Rocky Mountain and Pacific Coast States, and the establishment of National Forests under various modifications and extensions of the original act went on until most of the unappropriated public domain fit for the growing of timber in those regions was set aside for permanent public ownership and administration.

A further development of importance took place in 1911 when Congress made the first appropriation for the purchase of forest land on the headwaters of navigable streams. With the aid of subsequent appropriations this work has gone on until now the Federal Government has acquired some 2 million acres of forest land in the White Mountain and Southern Appalachian regions and the development of National Forests through land purchase seems to have become a settled policy in the United States.

A still further step in advance was made in 1922 when Congress provided for the blocking up of the National Forests into better administrative units through the exchange of forest land or timber for privately owned land within the forest boundaries. This should result in eventually adding several million acres more to the National Forests.

Along with the public sentiment which brought about and sustained the policy of establishing National Forests there naturally developed also a sentiment in favor of other forms of public forests. The most notable expression of this idea has been in the State of New York where some

2 million acres of land has been purchased in the Adirondack and Catskill regions for a State Forest Preserve and in Pennsylvania where about 1,550,000 acres of public forest has been established. In Wisconsin about 400,000 acres of land have been put into a forest reserve and several other states have made a substantial beginning in this direction. These states are also developing extensive forest nurseries.

At the present time, all classes of public forests in the Eastern United States total about 10 million acres with a stand of about 18 billion feet of timber, which is only about 3 per cent of the forest area and little more than 2 per cent of the stand in this region, since most of the purchases of land for National Forests in the East have been on a cut-over basis.

In the Rocky Mountain region, 87 per cent of the merchantable forest area and 75 per cent of the stand of saw timber is in public ownership. Such a large proportion in public holdings indicates very clearly that much of this area was not thought to be of great value prior to 1891 when the President was given authority to withdraw timberland from sale or entry. The fact that the 13 per cent of the total timber acreage in private ownership carries 25 per cent of the total stand of saw timber, also indicates that the best locations had probably been secured prior to the first forest reservations.

On the Pacific Coast 55 per cent of the merchantable forest area and 41 per cent of the stand of saw timber is in public ownership. Here also as in the Rocky Mountain region a considerable part of the most valuable and accessible timber went into private hands before Government reservations began.

Summing up the situation as respects forest ownership in the United States, we find an almost insignificant proportion publicly owned east of the Rockies but that taking the Rocky Mountains and Pacific Coast regions together some form of public ownership holds 72 per cent of the area and 47 per cent of the present stand of saw timber.

This is a larger proportion of publicly owned forest acreage than obtains in the leading European countries and compares favorably with the situation in Canada, where the policy has steadily been to maintain public ownership of forest land and to lease timber-cutting rights.

This heavy proportion of public holdings in the West with assurance that these areas will be under management with a view to continuous production is especially important since these two regions contain three-fifths of the remaining stand of saw timber in the United States.

In Canada.—In Canada, the long-settled policy has been to keep the bulk of the forest land in public ownership while selling the timber-cutting rights. The result has been that for the Dominion as a whole about 90 per cent of the forest area is publicly owned. The British North America Act gave the original provinces sovereign rights with respect to their natural resources, but for many years they have followed a common policy of getting agricultural lands into the hands of actual settlers, and of maintaining public title to the soil of forest lands. In Quebec, for instance, 94 per cent of the total forest area is in Crown lands. Apparently not less than 90 per cent of the present stand of pulpwood species in Canada is on publicly owned land, which is a condition exactly opposite that in the United States, and which naturally places upon the public greater responsibility for forest protection and replacement.

PART IV

TIMBER PRODUCTION

CHAPTER XII

THE NEED FOR FORESTRY

In the preceding sections of this volume we have stuck closely to the text and have discussed chiefly the use and supply of pulpwood in North America. This is the main purpose of our undertaking, but every species of timber which is used for pulp is also used for other purposes, and in some cases, these other uses are greater in volume than for pulp. We thus cannot escape considering the broad outlines of the whole problem of the timber supply of North America.

The present stand of all kinds and sizes of timber in the United States is estimated to be equivalent to 3,570 billion bd. ft. and in Canada to 987 billion bd. ft. The present drain upon the forests of the United States including the cut for every purpose and the estimated annual loss by fire, insects, and disease is equivalent to about 56 billion bd. ft. yearly. Were we to continue to use and destroy 56 billion bd. ft. each year until the present stand of 3,570 billion bd. ft. is completely exhausted, our timber would last 64 years, neglecting what growth might take place during this period. Similarly it is estimated that the present annual cut of timber in Canada for all purposes is equivalent to 11 billion bd. ft., which divided into 987 billion bd. ft., the estimated total timber stand in Canada, might indicate a 90-year timber supply.

As a matter of fact, we know that neither assumption is correct. In neither country will the timber ever be cut down to the last tree, because of inaccessibility, if for no other reason. The United States will not continue to use 56 billion bd. ft. yearly because the diminishing supplies of certain woods and increasing costs of all will restrict consumption. In the item of lumber, for instance, the annual cut has dropped from the maximum of 45 billion bd. ft. attained in 1907 and 1910 to about 34 billion bd. ft. and the per capita consumption has decreased one-third in the past 15 years. On the other hand, the annual cut in Canada will increase for some time to come, and thus go much beyond the present equivalent of 11 billion bd. ft. It is of some interest to note the possibility that the two countries will one of these times be on the same ratio of cut to stand allowing for probable further decreases in the cut in the United States and certain increases in the Canadian cut.

But this is not at all the right way to tackle the problem. We have been paying running expenses out of our capital, when if we are to continue on a solvent basis, our expenses must be paid out of income. It is undoubtedly true that the current annual rate of growth in the unmanaged and badly fire-damaged forests of the United States is very much less than the annual wood consumption. It requires no mathematical calculations to convince the ordinary observer that our forest bank account has been overdrawn for many years past. The successive cutting out of the virgin timber in the Northeast, New York and Pennsylvania, the Lake States, and soon in the South, is evidence enough on this score.

Foresters say that if scientifically operated and really protected from fire, the forests of Eastern Canada should show an annual growth of 2 per cent or 3 per cent a year. The annual consumption in that region is already more than 1 per cent of the total stand and probably now equal to the actual annual growth because effective forest protective and regenerative methods have not as yet been applied on the large scale that is necessary to secure continuous timber production.

The time has come when those who have millions of dollars invested in plants for the utilization of timber must investigate seriously the permanence of their supply of raw material and those who have enjoyed an abundance of every variety of forest products must be prepared to bear their share of the undertaking if they are to have in the future an even smaller supply at a higher cost.

We must begin to grow timber crops for use, and this is forestry, just as growing grain and hay is farming. Planting roadsides and caring for ornamental trees, desirable as these may be, is not forestry any more than caring for a flower garden is farming.

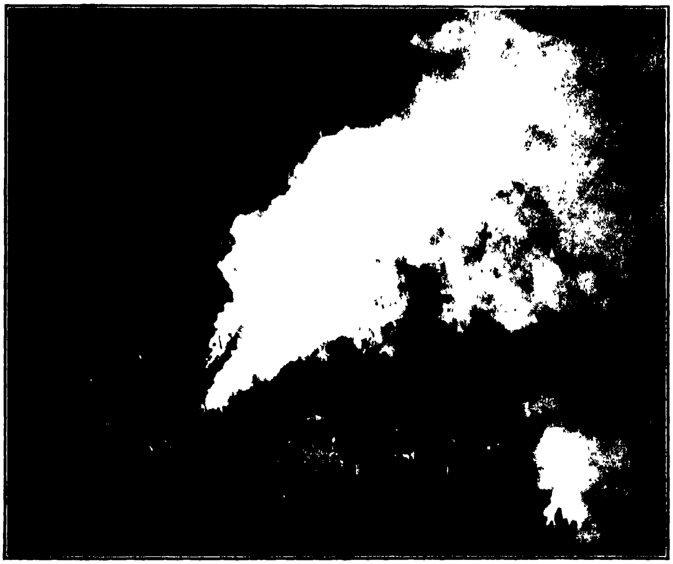


FIG. 75.—Forest fire in Oregon as seen from an airplane (photo by Jacobson).

"Forestry aims at continuously productive state forest lands, and the propagation, growth, and exploitation of the ripe timber crops in perpetuity" says the 1922 report of the New Zealand State Forest Service, and we cannot improve upon this statement which applies as fully to North America as to the other side of the world.

Untold benefit would have accrued to the people and the industries of North America had it been possible to establish effective forest protection 50 years ago. Now we must make the most of what is left of our timber stand and start a new crop if the next generation is not to be greatly pinched for wood, and the succeeding one still more handicapped.

CHAPTER XIII

THE CHANCE FOR FORESTRY

There are 330 million acres of timberland in the United States in various stages of cut-over condition, ranging from some 80 million acres upon which there is practically no prospect of new forest growth of commercial value without replanting to large areas upon which nature has succeeded in establishing another crop, which, if protected from fire, will some day yield forest products in large quantity and variety. There are also some 130 million acres of virgin timber, chiefly in the West. This remnant of what was once 800 million acres of mature forest in the United States is being depleted by cutting and fire at the rate of 5 to 10 million acres yearly. During some seasons more than 25,000 forest fires have been recorded in the United States ranging from small fires quickly discovered and put out which ran over only a few acres to uncontrollable fires which burned for weeks until extinguished by lack of further material to feed upon or by heavy rains. As many as 10 million acres of forest land have been burned over in the United States in a single season.

The same problem, but as yet not quite so acute because cutting has not gone so far, exists in Canada where the fire danger is even greater than in the United States. As noted elsewhere, twenty times as much timber has been destroyed by fire as has been cut by man in British Columbia. Fire has also done great damage in the eastern provinces as it has in the Lake States, New York and New England.

The 460 million acres of potential forest land in the United States and 300 million acres of the same character in Canada are sufficient to produce indefinitely the quantity of timber that is now being used for every purpose in North America. To do so requires the equivalent of an annual growth of only 55 cubic feet of wood per acre

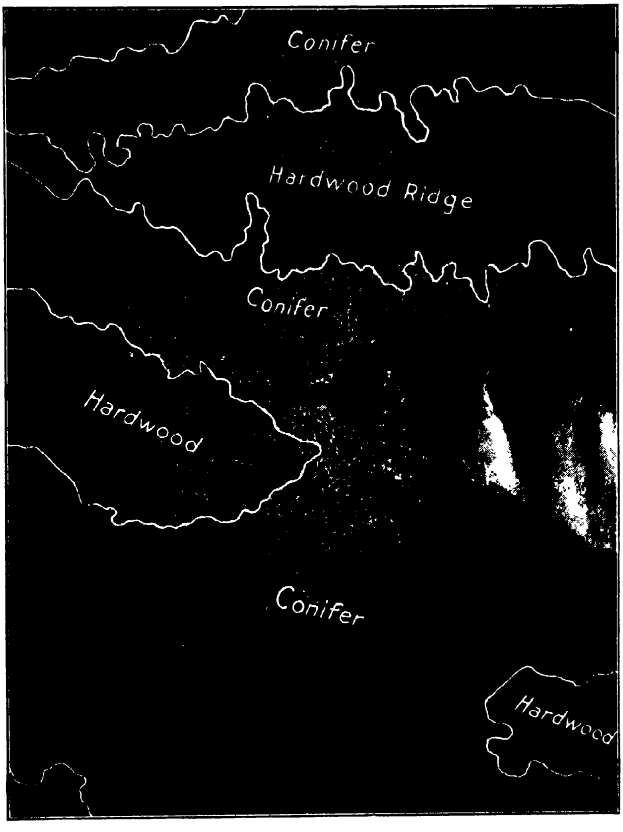


FIG. 76.—Forest types in pulpwood territory photographed from an airplane at 10,000 feet elevation.

per year in the forests of the United States without counting Canada at all. This is less than the present productive capacity of many well-managed European forests whether they be in France, Germany, Finland or Sweden.

It is stating the case conservatively to say that the quality of the forest soil of North America is as good as that of Europe and that our native timber species are equal to the European species in quality and rate of growth.

It is the problem of forestry to put this vast area of North America upon a basis of continuous timber production. It can and will be done—eventually. The start has been too long delayed. In many places we must begin now with barren land where a generation or two ago we could have begun with well-stocked land. Moreover, the Canadian problem in its elements is simpler than in the United States because in Canada 80 per cent or more of the forest land is held in public ownership, while in the United States nearly 80 per cent is in private ownership of widely diversified character. Public control of public property is natural and can be made successful, although this is often not the case. Public control of private property is seldom successful in bringing the desired results either to the public or to the private owner.

Where Forestry Should Begin.—Forestry should begin where the timber supply has been most reduced, because of the tremendous plant investment which has been built up to utilize the original stand of timber, the large communities which are directly dependent upon such plants and the more distant communities which require their products. The forests of the east have disappeared more completely and rapidly because of their nearness to the points where consumption has been largest. For example, 5 per cent of the total lumber consumption of the United States is in and adjacent to New York City, similarly 15 per cent of all the newsprint paper used in the United States goes through the printing presses in the same district.

Like charity, forestry should begin at home. It is a local problem of national significance. Space permits only a brief reference to the larger features of some of these typical problems. Something is known of what has happened in New York, New England and the Lake States, because the bulk of the timber of these regions has gone within the memory or observation of many persons now living.

New England originally had a forest area of nearly 39 million acres. The present forest area is supposed to be about 25 million acres, but the decrease of 36 per cent in forest area carries a decrease of 95 per cent in the stand or virgin timber. Of the present forest area it is estimated that 44 per cent carries saw timber or pulpwood, 34 per cent nothing of present value but fuel wood and that 22 per cent is wholly unproductive. Of spruce and fir, the most important pulpwoods, it is calculated that the present stand is equivalent to a little more than 20 billion bd. ft. or 40 billion cords. Contrasted with this is an annual cut for lumber and pulpwood in New England equivalent to 2,400 million bd. ft., together with an average annual importation of 500,000 cords of pulpwood by the pulp and paper mills. But few of the operating companies own a sufficient area and stand of timber permanently to meet their wood requirements. If the others are to continue in business as going institutions for many years to come they must get increasing quantities of raw material from outside sources or make larger use of other species than at present —doubtless they will have to do both.

Originally, nearly all of the State of New York was covered with a splendid forest of conifers and hardwoods. Today about 40 per cent of the total area is classified as forest land, although much of this is producing little. In fact, it is stated that nearly two-thirds of the present forest area is not producing material of kind or quantity suitable for either lumber or pulp.

The total stand of spruce, fir and hemlock in the state is calculated at an equivalent of 12½ billion bd. ft., but it must be remembered in this connection that 4½ billion bd. ft. of this total is in the State Forest Preserve where, because of the prohibitory clause in the state constitution, not even a dead tree can legally be cut for the improvement of the forest, let alone the utilization of any of its timber for the needs of the people of the state. The state of New York has gone half way in the practice of forestry upon public lands. It is planting trees and fighting fires. No use is made of the forests except for purposes of recreation and watershed protection. True forestry comprehends timber utilization as well as timber production.

At the present time the pulp and paper mills of the state are using an average of 1 million cords of wood yearly of which over 50 per cent is imported from Canada. The per capita cut of lumber for the state as a whole is equivalent to 30 bd. ft. compared with a per capita consumption of 200 bd. ft. yearly.

What has happened in the Northeast has been repeated on a larger scale in the Lake States. This region once contained the most useful and accessible single type of forest on the face of the globe. The original stand of white pine was perhaps not less than 350 billion bd. ft. In a little more than two generations it has been reduced to about 8 billion bd. ft. and the balance is going rapidly. The cutting of this timber in itself was not necessarily wanton. In fact, most of it was far otherwise, since the tremendous quantity of the finest lumber ever produced, billed at low prices to the Middle West between 1850 and 1900, was the greatest single contributing factor to the development of the agricultural and industrial resources of that great region, which today is the bread basket of the United States and also one of the most important sources of manufactured products. The permanent hurt to the country and particularly to the Lake States themselves, came through the fires which followed lumbering until today there is in Wisconsin, Michigan and Minnesota an area once heavily timbered estimated at 20 million acres which now holds little or no promise of a timber crop of any value within any reasonable period of human expectation, without forest planting on a large scale.

The pulp and paper industry of the Lake States depends chiefly upon the spruce and balsam of Minnesota, the hemlock of Wisconsin and Northern Michigan and pulpwood importations from Canada. The estimated stand today of spruce and balsam amounts to 3½ billion bd. ft. and of hemlock to 16 billion bd. ft. The annual consumption of spruce and balsam pulpwood is 690,000 cords and of hemlock equivalent to 500,000 cords. There is also an annual average production of 690 million bd. ft. of hemlock lumber drawn from the same source as the hemlock pulpwood. The Lake States pulp and paper mills are, therefore, importing from Canada an average of 56,000 cords of pulpwood yearly.

FIG. 77.—Natural growth of birch and poplar in 15 years after pulpwood cutting in Quebec. The problem of the foresters in this locality is to secure a stand of spruce and balsam.

Probably in no other important pulp and paper producing region are the operators less protected for their future supply of raw material through the ownership of sufficient timberland than is the case in the Lake States.

The situation in other parts of the United States with respect to raw material for paper making is not yet so acute as in these regions just mentioned, because elsewhere the industry is less developed and has made relatively much smaller demands upon the tributary forests for pulpwood. But the problem is of the same character, everywhere whether it be east or west, north or south, in the United States or Canada. Only vigorous and extensive measures of forest protection from now on will avert what otherwise may prove to be a real catastrophe not only for the comparatively few operators who have their money invested in a great industry, but what is much more important, for the 120 million people whose mode of life is based upon the use of forest products in every form from toothpick and clothes pin to daily paper and monthly magazine.

The solution should not be a restriction in the use of forest products forced by economic necessity, but the production of timber on a sufficient permanent scale to meet the need for such material.

CHAPTER XIV

THE METHODS OF FORESTRY

Forestry is not a law compelling the planting of a new tree for every one cut.

Forestry is not a law limiting the cut to certain sizes and kinds of trees.

Forestry is not arbitrary control by any public body over the operations of private enterprise.

Forestry is not fire prevention—though this is fundamental.

Forestry is the application of definite scientific principles to the growing and using of timber crops.

Forestry is and will be practiced by the private owner where he can see that it pays him to do so.

Forestry is and must be practiced by Government upon public property in order to insure some supply of forest products for the people. Because of the long-time investment and comparatively small return thereon, together with hazards of fire, insect, fungus and storm, a considerable area of publicly owned forests is always needed although public ownership of the entire forest area of any country is neither necessary nor desirable.

The proportion of total forest area in public ownership of some form in the leading European countries in the practice of forestry is 35 per cent in France, 53 per cent in Germany and 24 per cent in Sweden. Private capital engages in the growing of timber and cooperates with the public authorities in so doing in those countries, because capital gets a fair return therefor. Private capital will do so elsewhere under the same assurance of safety of return.

The methods of forestry vary with:

- Locality
- Topography
- Climate
- Species
- Stands
- Hazards
    - Fire
    - Storm
    - Insects
    - Fungi
- Forest Products Desired
    - Saw timber
    - Pulpwood
    - Fuelwood
    - Poles, etc.

It is a favorite charge of the "practical" man against the forestry profession that foresters are indefinite in their statements as to what must be done in order to secure a continuous timber supply in any particular locality. No reputable physician will prescribe for a patient in advance of a diagnosis. Only a quack deals in cure-alls. Neither will a forester undertake to say what should be done before he has carefully studied a given tract from all angles.

Working Plans.—The first step is always to find out the facts as to the present stand of timber on the tract under consideration, its rate of growth and all related factors as suggested in the preceding paragraph. The final result is a "working plan," designed to produce the results demanded by the policy of the owner.

The working plan is diagnosis, prescription and prognosis. There can be no hard and fast rule in dealing with biological entities, such as trees any more than with human beings of individualities, good, bad and indifferent. Some seedlings in the forest nursery grow twice as fast as others with no visible reason and in the same way will outstrip their competitors when transplanted to the forest.

The working plan must be flexible and subject to change in the light of experience. It must result in the production of timber at a cost reasonable to the operation involved else it is a poor plan or an impracticable operation has been attempted. What the forester advises and what the owner wants is a "sustained yield" of the products which the land will most profitably produce. The methods of getting this sustained yield are many and varied according to the practical conditions that must be met. There is need for more forestry in the woods and less in the textbooks.

FIG. 78.—Flooding of land by beaver dams sometimes kills considerable timber.

But it is as impossible to secure continuous timber production on an adequate scale without some sort of a "working plan" as it is to sail straight across the ocean without a compass. One may drift in a tub and land somewhere some day if he has good luck. Some kind and some quantity of timber may be produced without planning, but only an intelligently conceived and applied plan will meet the necessities of a given undertaking.

In the Adirondacks.—A typical working plan for the production of softwood timber (principally pulpwood) upon a 6,000-acre tract in the Adirondacks is reproduced beginning on page 239. A careful study of its provisions shows why there can be no general statement as to the measures necessary to produce timber over a large area. The plan in this case is for only a small tract of land, yet it required a large amount of conscientious, careful work. There had to be many tree measurements and topographical determinations, together with resulting detailed calculations of rates of growth for different species in different locations, probable future yields and the kind and quantity of timber that the owner might safely calculate upon cutting. Every working plan must contain such elements if it is to be of service. This is the method which private owners of timberlands must everywhere use if they wish to make their lands continuously and adequately productive.

In Quebec.—The situation is different where the public owns the land and simply sells cutting rights. This is true in the National and State forests of the United States and on the Crown lands and on lands under other designation of public ownership in Canada. Timber offered in public sale can carry with it any restrictions the owner sees fit to impose thereon. It is optional with the bidder whether he takes the timber subject to these restrictions or leaves it alone.

In the Province of Quebec where Crown lands comprise 94 per cent of the total forest area and where 45 million acres of these Crown lands are under lease to operators of pulp, paper and saw mills, the Government has decided that eventually all these limits must be cut by the lessees under definite working plans. The formal order by the Department of Lands and Forests for this purpose issued in March, 1922, was as follows:

> The undersigned, Minister of Lands and Forests, recommends the following:
>
> 1. The............................company is authorized to cut on the following timber limits a maximum quantity of ....cords;
>
> 2. The working plan of these timber limits will be revised not

later than 1932, and the quantity above mentioned will be modified if deemed necessary;

3. The boundaries of the areas to be lumbered every year will be blazed in advance, according to the annual lumbering plan, which must be prepared by the company and accepted by the Forest Service;

4. For the operations of 1922–23, the diameter limits will be as follows: For spruce and balsam on the slopes, ... inches on the stump, whereas on the terraces and the plateaus the cut can be made either in strip, that is, by clean cutting, or according to a diameter of ...... inches for the balsam and ...... inches for spruce;

5. In the sectors where the reproduction will not be found sufficient by the forest engineers of the department and of the company, the lumbering operations may be conducted so as to leave a certain number of seed trees per acre which will have been selected and blazed in advance. For the same reason, elsewhere, a clean cutting by strips will be allowed when the reproduction will be considered sufficient by the same engineers. Said engineers are also authorized to carry on any other silvicultural operations which they may consider necessary to insure a better reproduction of the forest. They are also authorized to regulate the best method to dispose of the slash on the ground;

6. All the merchantable timber will be removed up to four (4) inches in the tops;

7. No lumbering will be allowed in the brules or young forest which are not older than 40 years, except for thinning operations.

8. A joint inspection will be made by the company's man and the Forest Service as often as necessary during the lumbering season, in order to see that the stumps are cut low, the tops left small and that all the trees may be removed as provided for by the working plan and also to prevent the felling of seed and reserve trees;

9. All the debris must be removed or burned if possible on a width of 100 feet on each side of the roads which are travelled during the spring and the summer;

10. Sample plots for the control of the growth will be established jointly by the forest officers of the company and of the Forest Service, and searches will be made as often as necessary;

11. Each year the company must remove all the burned trees,

the windfalls, the insects and fungi-killed trees before the felling of any green trees. The volume of said defective trees must be deducted from the maximum amount for the annual cut.

Many working plans based upon studies of timber stand and growth in the localities covered have already been filed with the Department of Lands and Forests and work of this character is proceeding rapidly in the Province of Quebec. An outline of the forest surveys and working plans required of limit holders who wish to cut under the legal diameter is reproduced on page 247. This gives a very clear idea of the factors which must be considered and the studies which must be made as a basis for working plans.

FIG. 79.—Pulpwood decayed beyond possibility of utilization following budworm attack.

In British Columbia.—A typical timber sale contract form involving pulpwood in British Columbia is reproduced beginning on page 252. It will be noted that while this contract does not call for a definite working plan, as is the case in Quebec, nevertheless, the contract itself through the provision that no timber can be cut except that marked by a forest officer; and the other provisions as to felling methods and disposition of brush are sufficient if properly applied and followed by effective fire prevention to allow opportunity for nature to produce another crop of timber following the cutting. The form of the contract is evidence of the purpose of the forest officers to maintain the productivity of the forest.

In the National Forests.—A timber sale contract form of similar character offered by the United States Forest Service for timber in a National forest is reproduced beginning on page 255. As in the British Columbia contract, the meat of the whole matter is in the provision that only timber marked by the forest officer shall be cut. Before putting this timber up for sale the Forest Service, through its own studies, made some sort of a working plan for this particular area and came to the conclusion that cutting of the character permitted under the terms of the sale, together with subsequent forest protection, would establish conditions which should result in another crop of timber.

These examples are sufficient to indicate the methods that must be followed to secure continued timber production whatever may be the character of land ownership. The object is to increase or maintain the proportion of valuable species in the forest against those less valuable. In some localities and for some purposes these may be certain softwoods as against other softwoods or hardwoods. In other localities the purpose of management may be to secure hardwoods instead of softwoods or to increase the proportion of certain more valuable hardwoods compared with those of less value. It is no simple task. There are "weed trees" in the forest just as there are weeds in the cornfield which reduce the yield. The forester must work everywhere in conformity with the laws of nature and the condition of the earth as he finds them. He can guide, direct, stimulate and protect, but there are rigid limits which he cannot exceed in any direction.

CHAPTER XV

THE HAZARDS OF FORESTRY

Because of the character of the property and the long periods of time involved there are many hazards in forestry. Timber may be carried 49 years safely and growing profitably and in the fiftieth year it may be completely wiped out by fire, storm, fungi or insects. We have numerous examples of tremendous damage to the forests of North America by all these causes. The cartoon by Reid, Fig. 81, well expresses this unfortunate phase of forestry operations. It is said by those competent to judge that complete protection from fire is 75 per cent of the solution of a commercially valuable future timber crop in North America, taking the country as a whole, and more than 90 per cent in some localities. Fires are chiefly due to some form of human carelessness and can be largely prevented. With storms, fungi and insects, little can be done but to make the best possible utilization of what remains after the catastrophe.

Within the last few years we have seen the chestnut completely disappear from the forests of the Northeastern States due to a blight against which no means of protection have been found, and from all indications this will continue until our native chestnut has vanished from its entire natural range as one of the most valuable timber trees of the East. Similar, but not so devastating, is the white pine blister rust which has done great damage to the white pine in the Northeastern States and which is spreading westward despite the expenditure of large sums of money to head off its advance. The larch saw-fly killed practically all the mature tamarack in New York and New England and more recently has done the same thing in the Lake States. The young tamarack is coming along, however, so the species will not be destroyed as apparently will be the case with the chestnut. Some 20 years ago pine beetles killed a large quantity of timber in the Black Hills. Today more than a million and a quarter acres of the most valuable yellow pine in the West is threatened with destruction by the bark beetle. Since 1910, in this infested district in southern Oregon and Northern California, it is estimated that there has been a loss of more than a billion feet of timber through the depredations of this insect. Large sums of money are being spent in cooperation by the timberland owners and the Federal Government in combating this attack, and it perhaps may be headed off. Large areas of timber are thrown by wind in various parts of America.

Most serious of all has been the destruction of pulpwood resources caused by the budworm in the Northeastern States and Eastern Canada since 1909. No one yet knows the extent of this damage, because, while the actual attack by the insect itself in its defoliation of growing timber has largely ceased, the trees which are not immediately killed are in their weakened condition an easy prey to decay and insects of other kinds, so that they continue to die for several years after the budworm has left them. Neither do we know as yet how much of this timber it will be possible to get out of the forests and make into some useful product before other insects and decay have completely destroyed its value. The presence of such a large amount of dead and dying timber in the forest also adds greatly to the fire danger.

The attack has been chiefly upon balsam fir, although considerable spruce has also been affected and in some cases hemlock. Some say that 150 million cords of pulpwood have been practically killed by the budworm in the Province of Quebec. Others put the amount at 75 million cords. Great damage has also been done in Maine and New Brunswick, where careful examination of particular tracts of considerable size shows that as high as 80 per cent of the balsam fir has been killed. The best thing that can be done in such circumstances is to cut all the infected trees and get them out of the woods as quickly as possible; but cutting on large timber areas must be handled according to some well laid out plan and in natural topographic units, so it is manifestly impossible to go over the entire tract and take out only the damaged timber as soon as the damage is noted. Under such circumstances, clean cutting of infected areas is the only practical means of checking the budworm attack.

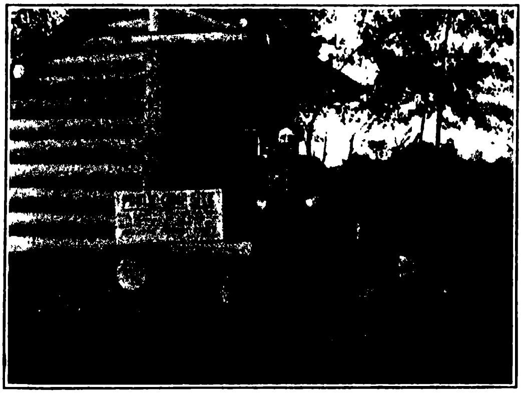


FIG. 80.—Making it easy for the camper to be careful with fire. Public camp furnished by the New York Conservation Commission.

The budworm has not destroyed the seedlings and smaller trees, so another crop is coming on. However, this susceptibility of the balsam fir to budworm attack and the knowledge of similar previous attacks is causing foresters to give more thought than ever before to the possibility of reducing the proportion of balsam in the timber stand or else of cutting it earlier than the more valuable spruce.

CHAPTER XVI

THE COST OF FORESTRY

The so-called "cost of production" of forest products in North America has in general been merely a harvesting cost, that is, the expense of logging and manufacturing plus whatever the market price might be for stumpage, but rarely has the stumpage price equaled what it would cost to grow timber of the same kind and quality. The growing of timber is analogous to the growing of other crops upon land except that the usual crop is sown, grown, harvested and marketed within a 12-month period, while the same series of operations in timber may run from 50 to 100 years. The elements of cost are the same in both. Capital will not seek investment in either unless there is reasonable chance for profit. We have abundant data upon the cost of growing farm crops and upon the cost of manufacturing commodities, but little information upon the cost of growing timber.

A permanent timber supply will not be maintained by private effort at less than the cost of production and eventually timber grown upon public lands should also bring its cost. There are four main elements in computing what it will cost to grow a crop of timber. They are:

1. The value of the land.
2. The stocking of it with young trees.
3. The administration of the operation and protection of the young growth.
4. Taxes.

These elements are present as actual money outlay in a private operation and their equivalents cannot escape consideration in the growing of timber upon a public domain.

The profit or loss at the end of the given period is determined by the relation between the combined amounts of these investments and the value of the resulting stumpage at prices then obtainable; or the total amount of the investment at a specified compound interest rate divided by the total yield will·give the absolute cost of production per unit of yield at such rate.

Land Values.—All these elements vary according to locality and other conditions. Land suitable for the growing of timber but not farm crops may range in value from $2 or $3 to $10 or $15 per acre. No large-scale forestry operation for general timber production can be carried on with high-priced land. The operation will not stand the charge.

The stocking of land with young trees, if it is completely barren to start with and the trees must be planted, may cost from $10 to $15 per acre. On the other hand, it may be possible to so conduct cutting operations in a present timber stand where there is good natural reproduction, that the first cost of the new stand will be materially less than a planting cost. Forest planting is ordinarily the last resort of the forester in his efforts to get a stand of timber. It is easier and simpler for him to work with natural reproduction, although Nature's planting may not be as uniform as that of man.

Over large tracts, the cost of administration and protection should amount to only a few cents per acre annually. Taking the forest regions of the United States as a whole it is estimated that a charge of 3 cents per acre per year would give sufficient protection from fire. In some localities, however, there are other hazards to be guarded against.

Taxes.—Taxes are exceedingly variable. The general property tax, if strictly applied to growing timber, is prohibitory, since a crop which it may require 100 years to produce will be taxed upon increasing values during each of these 100 years. The uncertainty and variability of the application of the property tax has been a greater deterrent to the private owner in his plans to make his land permanently productive than the actual application of it, because he cannot forecast what may be charged against him next year or the year after. Foresters, economists and timberland owners are rather generally agreed that for taxing purposes forest property should be segregated from other real estate and that land devoted to the growing of timber should be taxed annually only upon its value as bare land and that when the timber is finally harvested a tax upon the value of the product should then be levied. The tax on yield falls at a time when the owner of the timber is best able to pay, hence unlike the general property tax, it has no tendency to make any one cut when the market is overstocked or before the timber has reached the most profitable cutting stage.

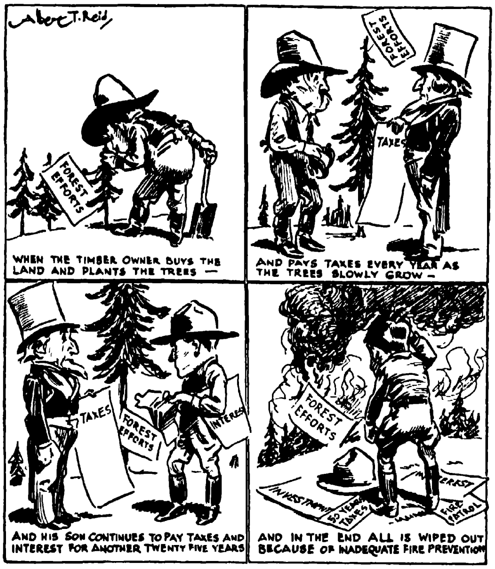

Albert T. Reid
FOREST EFFORTS
WHEN THE TIMBER OWNER BUYS THE LAND AND PLANTS THE TREES —
FOREST EFFORTS
TAXES
AND PAYS TAXES EVERY YEAR AS THE TREES SLOWLY GROW —
TAXES
FOREST EFFORTS
INTEREST
AND HIS SON CONTINUES TO PAY TAXES AND INTEREST FOR ANOTHER TWENTY FIVE YEARS
FOREST EFFORTS
INVESTMENT
50 YEARS TAXES
INTEREST
FIRE PATROL
AND IN THE END ALL IS WIPED OUT BECAUSE OF INADEQUATE FIRE PREVENTION

Fig. 81.—Looks as if no forest policy means no timber.

Interest Rates.—Rates of interest depend upon the risk involved and the ease with which the money invested in the enterprise can be recovered. The soundest investment at the present time (United States bonds) yields something over 4 per cent. Most real estate mortgages are upon a basis of from 5 to 6 per cent. Values of farm land generally tend to rise until for the usual farm crops a return of not over 4 or 5 per cent is secured. Forest land is usually the poorest land in the region and often of no economic value for any other purpose. Forest investment is a long-time one and with proper community fire protection requires little attention upon the part of the investor during the time that the investment runs. On the other hand, there is not yet any generally available insurance for standing timber in America nor will there be until fire prevention methods are more effective than at present. Until conditions become such as to make either commercial or mutual insurance feasible there remains an element of hazard in timber investments, allowance for which will be made by each investor as seems to him best. Forest fire insurance has long been in operation in some European countries. When conditions become such that forest insurance can be established in America (and this should be soon in some localities) a long step will have been taken in the direction of making investments in the growing of timber attractive to private capital.

Under all these circumstances, it is natural that there is a rather wide divergence of opinion among foresters as to the rate of interest that is proper for the calculation of costs in the growing of timber. Many have held that a rate of 4 per cent is enough, but this to some extent is based upon the fact that much timber in itself does not increase more than 2 or 3 per cent yearly and that the operation will not stand a high interest rate. On the other hand, the business man accustomed to the hazards of enterprise thinks that forestry should pay at a much higher rate than 4 per cent. For many calculations a rate of 6 per cent would seem to be a reasonable compromise between these viewpoints and one not too high for the operation concerned.

The most important point to be borne in mind in this connection is that we are talking about compound interest. It is necessary to figure compound interest in operations which yield deferred returns as is the case with forestry and this makes it particularly important that the initial investment be kept to the lowest possible figure. For example, if our initial investment in timber is only $10 per acre and the cut is made at the end of 50 years the cost at 3 per cent will amount to $43.84, at 4 per cent to $71.07, at 5 per cent to $114.67 and at 6 per cent to $184.20. In other words, the amount at 6 per cent compound interest for this period is 60 per cent more than at 5 per cent and more than four times the amount at 3 per cent compounded annually.

Some Examples.—Let us apply the foregoing principles to a typical region.

According to the Forest Service report in response to Senate Resolution 311, fifteen forest owners hold some 5½ million acres, or nearly one-quarter of the forest area of Maine, New Hampshire and Vermont.

The present consumption of pulpwood in these three States averages about 1,700,000 cords yearly. An annual growth of one-third of a cord of pulpwood on the acreage held by these fifteen owners would equal the present consumption. It is not unduly optimistic to expect an ultimate annual growth of pulpwood at this or a better rate if conditions of forest protection and taxation become such as to make it a safe and profitable undertaking for corporations to carry on long-time operations of this sort in order to provide raw material for their mills.

The following are some of the possibilities which may be considered:

CASE I

1. A cost of $15 per acre for land and the stocking of it with young trees, either through planting or natural reproduction.

2. An annual protection charge of 5 cents per acre.
3. Six per cent compound interest on the investment.
4. We are justified in assuming that in the future we are likely to have a cutting tax instead of an annual tax upon private land devoted permanently to forest growing, and we are setting a tax of this kind high enough when we make it 16⅔ per cent upon the final yield, which is equivalent to an annual tax of 1 per cent upon actual value with a 6 per cent interest rate.
5. Under exceptionally good conditions we may get a yield of 20 cords per acre at the end of 40 years. Applying the usual formulas of forest finance, we get $10 per cord at the cost of growing such pulpwood stumpage.

CASE II

The other factors in Case I remaining the same, a yield of 15 cords at the end of 40 years will show a cost of $13 per cord, and of 10 cords, a cost of nearly $20 per cord stumpage.

CASE III

1. Land and stocking, $10 per acre.
2. Protection, 5 cents per acre.
3. Six per cent interest.
4. Yield tax, 16⅔ per cent.
5. Yield of 15 cords per acre in 50 years.

The cost in this case becomes $16 per cord for pulpwood stumpage.

CASE IV

Same conditions as in Case III except an interest rate of 5 per cent. The cost per cord then becomes $10.

The foregoing illustrations show that only with a low first cost and high final yield within a comparatively short period of time will the operation stand as high an interest rate as 6 per cent. Under the conditions assumed in Case III, a 6 per cent rate makes a cost of $16 per cord while a 5 per cent rate gives a cost of only $10 per cord. Where a large plant investment is involved with an uncertain supply of raw material, it may be more profitable to maintain a going manufacturing operation through the growing of the raw material even at a comparatively high cost than to liquidate the investment and turn the proceeds into other channels. It is also evident that in blocking up a holding for forestry operations every effort should be made to get land at a reasonable figure which is well stocked with natural young growth, or if it carries a merchantable stand, land which can be cut over and protected in such fashion that it will reproduce cheaply.

It should also be borne in mind that a cost of $10 or $15 per cord for growing pulpwood stumpage may not be prohibitive of profitable manufacture into paper by the time such stumpage is fit to cut. Cases of purchases of pulpwood stumpage at $5 or more per cord have already occurred. If a cord and a quarter to two cords of wood are used to make a ton of paper, an increase of the amount suggested in the cost of the wood will not put the price of paper out of line with the cost of other articles made from wood when we get to the stage where the cost of growing timber must be met through the price of the finished product.

FIG. 82.—Natural reproduction of spruce and balsam fir in New Brunswick—trees about 25 years old.

Such considerations as the foregoing must be taken into account by executives who determine operating policies and foresters in their employment must be prepared to furnish reliable figures upon which such policies may be based.

This illustration of the effect of commercial interest rates compounded shows why it is that for kinds of timber which must be left to grow to large size or for long periods of time, public ownership of forest land must be largely depended upon. Private capital cannot stand the rapidly mounting charges, while a 4 or 5 per cent rate is not uncommon in public undertakings. Public assistance has been afforded in order that agriculture may receive the benefits of a low interest rate, and it would seem equally appropriate to render similar assistance to land owners who will meet proper requirements in timber growing.

To facilitate the calculations of those who may wish to study particular cases, some cost tables are given in the Appendix, page 262.

CHAPTER XVII

THE RESPONSIBILITY FOR FORESTRY

Wood is a basic material in our industries. It is an essential component of a multitude of articles of daily necessity. Merely enumerated without explanation, the names of the articles in which wood is the sole or an important constituent would require many pages of paper, made chiefly of wood itself. We can no more conceive of a state of society on this continent with wood totally eliminated than we can of one in which iron has no part.

Forests supply raw material for industry, protect watersheds, furnish recreation grounds for the people and a refuge for wild life of every kind.

National Economy.—A sound national economy demands not only the right use of our natural resources, but still more important, the early adoption of a policy which will insure a permanent supply of all products and materials essential to the progress and prosperity of the people. The problems of the present and future use of timber, of coal, of oil, of iron and other minerals, are all parts of the one great problem of the wise use of the resources which nature has provided for the benefit of man. Unlike the mineral resources, however, the forest resources are reproducible. An exhausted mine is exhausted forever. Cut-over forest land can be made to produce another forest as good as or better than the original. Hence the use and reproduction of timber can go hand in hand if we know enough and are able to take advantage of Nature's laws.

The forest problem is essentially a land problem. National economy requires the best and fullest utilization of all our land and water surfaces. No forester or private land owner advocates the permanent growing of timber upon land which will yield higher returns and more essential products when put to other uses. Every forester and every thoughtful citizen agrees that land which is suited to the growing of timber and which does not have a more essential use for other purposes should be kept permanently producing timber. The only question for discussion is that of ways and means.

The growing of timber is a long-time undertaking. No matter how promptly or how extensively we begin the preparations for a future crop, we cannot sufficiently bridge the gap between present and future supplies to enable us to cross it with comfort. In the absence of a general land classification, it can be conservatively estimated that 20 per cent of the land area of North America or about a billion acres is better adapted to the growing of timber than to the ordinary forms of agriculture. Moreover, there is no likelihood that for a long time to come will the pressure of population demand for other uses any of this billion acres of potential forest land. Still further, distributed as this land is throughout the Continent, it is capable under the right management of permanently producing a sufficient amount of the kinds and qualities of timber required for all domestic purposes as well as a considerable export trade. It is the part of wisdom and good citizenship to institute as rapidly as possible the measures which will bring this about.

Who Is Concerned.—While every citizen is vitally concerned in this problem, the logical solution of it demands the recognition of three groups, each having especial interests in certain phases of the undertaking. These are:

The public or the users of the forests. The interests of the public are fundamental and in the long run will prevail. The supply must be maintained.

The manufacturers or converters of timber. Viewed from the business standpoint only, the interest of the manufacturer in the forest is that of a source of raw material. The question of a steady supply is to him more important than that of who produces it. His function is not necessarily to grow timber but to convert it into merchantable commodities. The miller is not the man who grows the wheat. When, however, the converter of timber into usable products is unable to assure himself of a dependable outside source of raw material and he has a large plant investment requiring many years to amortize, he is very likely to enter the field of timber growing as a matter of investment insurance if for no other reason.

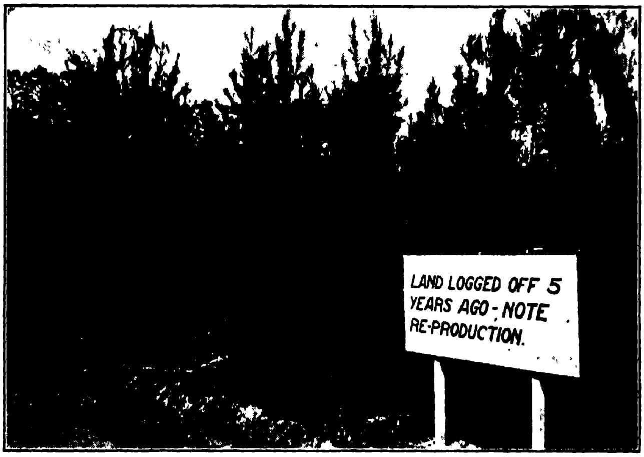


FIG. 83.—Natural pine reproduction in Louisiana.

The timberland owners or the producers of timber. The land owner is interested chiefly in a market for his timber. From a selfish standpoint he is interested in the protection of his property from destruction by fire or insects. Because of the long-time investment necessary, the hazard of the venture and the probable low rate of return, the timberland owner is not generally interested in the question of a second crop of saw timber. His natural inclination is to make the most he can out of the present one (which he did not plant) and after cutting get rid of the land as best he may. He is likely to say that morally and legally he is no more bound to plant trees and grow timber on his land than is the owner of other land bound to grow wheat or cotton upon it in case he does not desire to do so.

In some cases private, and more especially corporate, owners of timberland are finding it to their advantage to put their land upon a permanent producing basis for specialized wood crops where the timber can be profitably utilized comparatively young and in small sizes. Such commercial timber growing will doubtless increase in the future and should receive public aid and encouragement. But these undertakings afford no basis for legal compulsion upon the private land owner to keep his land forested except in cases where after proper classification and indemnification it may be decided that the general welfare demands watershed protection.

Essentials in the Solution of the Problem.—Any program looking toward the solution of the problem of a permanent timber supply must be:

a. Adequate and practicable to produce the needed results.

b. Just to all interests concerned.

c. Acceptable to the majority.

It is evident that to grow the bulk of the older and larger sizes of timber, public ownership of timberland—National or State, Dominion or Provincial, with private cutting and marketing operations—is the most feasible solution of the problem. The production of large-size timber is too long an undertaking with too great hazards and too low a rate of return to attract private capital in adequate amount. Governments, whose primary concern is the welfare of all citizens and industries, can best afford to engage in the growing of such timber at a low rate of return upon invested capital. On the other hand, the public will get much better service if the operations of transforming stumpage into merchantable commodities and their distribution are left to the energy, initiative and ingenuity of private capital under such silvicultural regulations as will best perpetuate the supply of raw material.

CHAPTER XVIII

WHAT SHOULD BE DONE

As has been said repeatedly, but cannot be emphasized too much, the first essential is effective fire prevention. Much progress has been made in this direction in the past 10 years in both the United States and Canada, yet a season like 1922 on the Pacific Coast and in Eastern Canada reminds us once more that fire is still the greatest enemy of our forests. Many fires cannot be stopped, but nearly all fires can be prevented through constant and proper precautions during the danger season. Public carelessness is by far the greatest contributing cause to our annual fire loss. Had not fire after fire followed timber cutting in North America from the earliest days to the present time there would be no such shortage of wood as impends today. Adequate fire prevention from now on is more important than any other one factor in the securing of a future timber supply.

There is need for a National working plan in the shape of a forest policy to establish conditions which will make all forest land productive just as the individual owner must have a working plan if his own operations are to be conducted intelligently. For the country as a whole there should be an adequate forest survey and land classification to determine what we have, where it is, and how much there is of it. A forest inventory is needed just as much as an inventory is needed in any going business.

Some notable results in the way of timber reconnaissance and mapping are being secured through airplane photography. The airplane is also proving to be a very helpful means of locating forest fires promptly and accurately, and

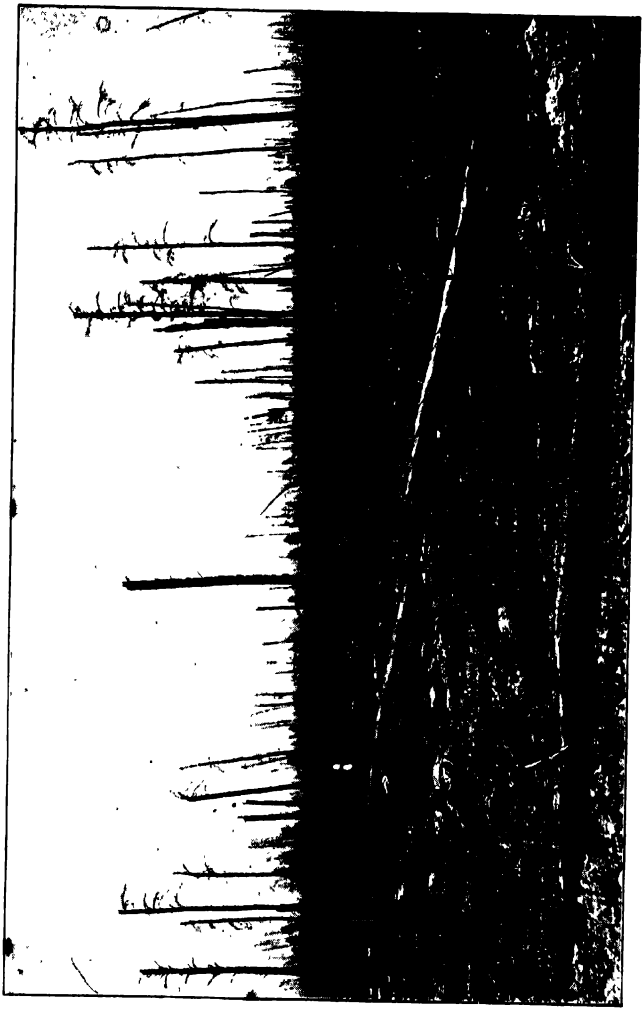


Fig. 84.—The forest after fire has done its work.

even of transporting men and supplies to the scene of action.

The most effective use of the airplane for these purposes so far has been on the Pacific Coast and in Eastern Canada.

In the United States, areas of public forests, particularly in the East, need to be built up through land purchase. In the West the existing public forests in many cases should be consolidated for better operation through exchanges with private owners whose holdings are intermingled with those of the public. Such exchanges will enable forestry to be practiced under both ownerships.

In the United States.—*Federal Policies.*—In his capacity as Chairman of the National Forestry Program Committee, the author has recently had occasion to sum up the minimum of additional Federal legislation immediately needed in the United States in the following statement which has been rather widely reproduced:

CARDINAL FEATURES OF A NATIONAL POLICY TO SECURE CONTINUOUS FOREST PRODUCTION UPON ALL LANDS CHIEFLY SUITABLE THEREFOR

Twenty per cent of the forest land in the United States is in public ownership and being administered upon the basis of permanent production of timber crops. Eighty per cent is privately owned, and due to conditions over which the owners have no control much of it is not being handled upon a productive basis.

The problem, therefore, is to formulate a national policy of Federal leadership and cooperation with the states and with timberland owners which through conservation and utilization will permanently supply the quantity and variety of forest products that the country must have if progress and development are to be maintained.

The time has now come when the policy of establishing national forests, initiated 30 years ago and splendidly administered by the Department of Agriculture, must be rounded out and supplemented by the enactment of legislation which will permanently provide for:

1. Adequate cooperation with the States in fire prevention, the National Government to spend no more for this purpose in any State than the State itself spends therefor, according to plans approved by the Department of Agriculture. Fire prevention is an absolutely essential requirement for the safeguarding of the present supply of mature timber and the protection of the young growth which will furnish the timber of a few years hence.

The Federal appropriations for this purpose during the last 11 years have directly led to expenditures by states and private owners in 7 times as great amount, thus demonstrating the far-reaching results of Federal leadership. During this period the States cooperating with the government have increased from 11 to 26 and the area given some degree of protection has risen from 61,000,000 acres to 166,000,000 acres. The privately owned forest lands which need systematic protection total 332,000,000 acres.

The current appropriation for this purpose is $400,000. It should be not less than $1,000,000.

2. The continuation of purchase of land for National forests upon the watersheds of navigable streams and encouragement in the establishment of state and municipal forests until public forests amount to not less than 40 per cent of our total forest area.

This is necessary not only for the protection of. watersheds, but also to furnish the backbone of our timber supply, for only in publicly owned forests is it possible to grow the larger sizes and older timber which we will always need.

The average yearly expenditure provided by Congress for this purpose for the past 12 years has been $1,085,000. This established policy should unquestionably be maintained.

3. Forest research and investigation is necessary to determine the best methods of reproducing the most valuable species and the most economic use of all species.

The current appropriation for this purpose is $425,000. It should be moderately increased.

4. Forest planting is necessary in order to restore millions of acres of fire-swept lands to productivity. There should be an annual appropriation of at least $100,000 to start this work.

5. The taxation of forest lands and the exercise of the police power to protect them are matters of State concern. Studies of these problems

by the Federal Government and recommendations for their treatment will help greatly toward justness and uniformity of results.

None of these items can rightly be charged to the National expense account. They are investments in the future and permanent welfare of the country—an insurance upon one of our greatest and most necessary natural resources.

State Policies.—There is need in the United States for still greater Federal leadership and cooperation with the States in the solution of many problems relating to timber production and utilization. In the United States there is much need that the States, and in Canada that the Provinces, should cooperate much further than they have yet done with the owners or the lessees of timberlands in the working out of measures for the protection of timber. In this connection we can do no better than to quote the recommendations made by the Forest Conservation Committee of the American Paper and Pulp Association with respect to the principles which should govern the formulation of adequate state forest policies to be developed in harmony with a National Policy of the character previously suggested. It is the belief of this Committee, made up alike of foresters and timberland owners, that effective state action should provide:

1. That it is a fundamental principle in State economy that the soil which is a basic wealth producer shall be made reasonably productive, either through the application of agriculture or forestry.

2. That while both agriculture and forestry deal with crops from the soil there should be a clear distinction based upon the fact that methods used in the production and utilization of the forest crop are fundamentally different from those applicable to farm crops. That the administration of the natural resources of the State should be under a conservation commission subdivided into departments of forests, waters, fish and game, and that the men appointed by the commission to head these departments should be especially qualified by education and experience to carry on the work of those departments in the most efficient

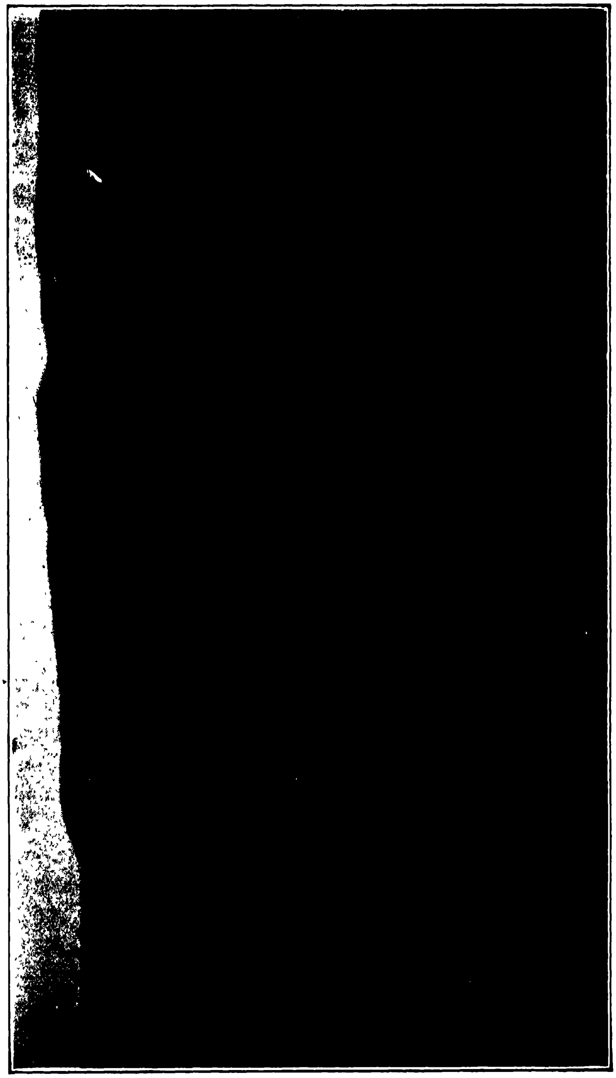


FIG. 85.—Part of a forest nursery of a paper company which has a capacity of 5,000,000 young trees yearly.

manner, and to cooperate with the Federal Government in accordance with the plan proposed in the preceding section of this report.

3. That appropriations should be made and means given for a thorough survey of the State, that it may be known just what is forest land and what is agricultural land. Such surveys should be carried out in cooperation with or through aid given by the Federal Government.

4. That the lands of the State should be so classified for the application of forestry that the forests necessary for protection of water supply or of slopes of hills and mountains of such character that it is unsafe to remove the forest cover, shall be acquired and set aside as parks, such forest parks to be dedicated to recreation and to the protection of the wild life of the forest. The remaining forest lands should be utilized both for direct returns from timber and indirect returns from game and recreation.

5. That protection of the forest from fire and other destructive agents is fundamental, and therefore organized fire protection should be State wide. Private owners should share an equal burden with the State in forest protective measures in proportion to the area of timber land owned and the amount of protection given. That the State be empowered to cooperate fully with the Federal Government in plans for fire protection.

6. That the commission and the various departments empowered to carry out the conservation laws of the State shall be given authority after due procedure to determine regulations necessary to protect and develop those natural resources. No State law should attempt to define methods and details of protection, management, etc.

7. That industries dependent upon the forest may be permanent in the State, there shall be such adjustment of taxes upon forest lands as will insure the permanency of the private ownership of forest land. This to be done either through the taxing of land and timber separately or by the timber tax being collected as a yield tax at time of cutting, or by the Federal Government through the State, or the State itself assisting in supporting county and town government, later to be reimbursed by the collection of the yield tax.

8. That assistance in the practice of forestry be given the pri-

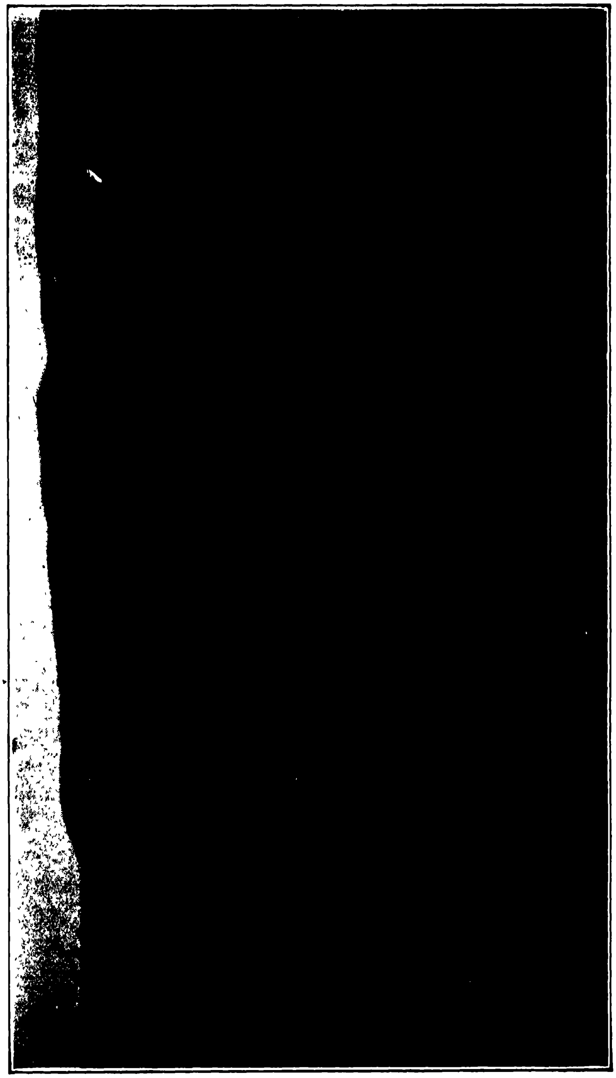


Fig. 85.—Part of a forest nursery of a paper company which has a capacity of 5,000,000 young trees yearly.

represent a minimum which should be adopted in the near future:

A definite policy of fire prevention on a cooperative basis between the Government, the wood-using industries, the land owners, license holders and the railways.

The placing of all land sales and control of cutting operations on Government-owned lands under the direction of properly qualified forest authorities. In some cases there is now a separate branch which handles timber sales. This hinders the best forestry administration.

The Provinces should adopt the policy of cutting timber in such manner as to secure a sustained yield instead of the present diameter limit regulation. Cutting to diameter limit only is not forestry. There should be closer check on the quantity of wood cut on licensed lands, closer supervision of cutting methods, and more accurate inventories made of the timber before lands are put up for sale.

The total timber supply of each district and the probable future yield should be determined and no more mills allowed to operate than the forest will sustain permanently.

Several of the Provinces are getting large yearly revenues from the sale of timber without giving adequate return in forest protection and regeneration. In other words, they are using up their forest capital in much the same fashion as the private owner of timberland is so frequently criticized for doing. Public ownership of land fit only for forestry is not justified unless it is so managed as to produce timber crops permanently.

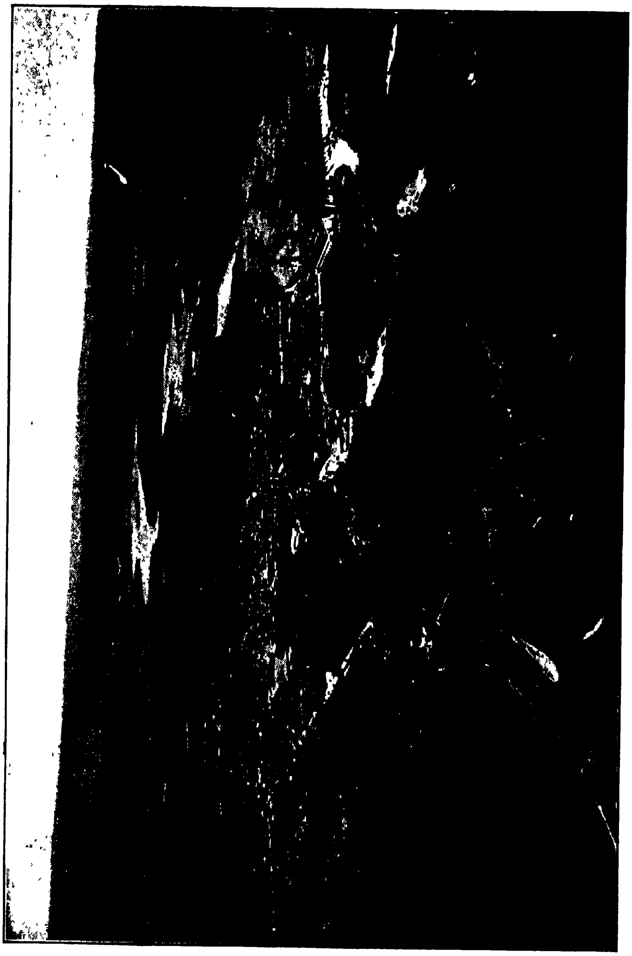


FIG. 86.—Airplane view of a modern pulp and paper mill and surrounding country. 180,000 hp. developed at this site.

PART V

A PERMANENT INDUSTRY(?)

CHAPTER XIX

TO GROW MORE WOOD

It is inconceivable that a billion-dollar industry like the manufacture of pulp and paper in North America should allow itself to be starved to death for raw material. Wood is the best, most widely available substance for the making of paper that the world has yet discovered and the world never had enough paper until wood was used. The solution is not to find a substitute for wood, but to *grow more wood.*

More usable fiber per acre per year can be produced from wood than from any other crop adapted to our conditions and suitable for the making of most grades of paper. Our survey of the situation has shown that:

> We have all the land that is necessary for the growing of timber and that is fit for nothing else under a sound national economy.
>
> It is located sufficiently near great waterpowers to make the utilization of the timber crop for paper entirely feasible.
>
> We have sufficient knowledge of the methods of growing timber.
>
> We have a magnitude of investment that renders necessary an assured supply of raw material.

The pulp and paper industry in North America, like the other great wood-using industries, can and will be put upon a permanent basis, if all the parties at interest will pull together. This includes every citizen whether he lives in the woods or in the heart of a great city.

There is no sense in wasting any time or in delaying the effort to maintain the American timber supply on the assumption that we can turn to any other part of the world

FIG. 87.—Fire—the greatest enemy of the forest.

for any considerable proportion of the wood products that we need.

We must grow the bulk of our own raw material or go without.

The strongest competitors of the pulp and paper mills of North America in the world's markets today are the mills in the countries which long ago learned the necessity for stabilizing their forests. Germany, Scandinavia and Finland are the great pulp and paper producing countries of the world outside of the United States and Canada. They went through a period of forest devastation generations ago. For many years the annual cut from their forests has not exceeded the equivalent of the annual growth. Even during the stress of the great war with wood called upon to meet many new uses, Germany did not overcut her forests and the cutting of the French forests was not advanced by more than 10 years. In these countries it is the forester who determines how much timber of each kind may be safely cut each year from a given tract. The manufacturing operations must be shaped to fit the allotted supply of raw material.

Is the native enterprise and ability, so evident in a thousand ways in North America, unequal to a problem which was long ago solved elsewhere?

APPENDIX

Table 1

THE PULP AND PAPER INDUSTRY IN THE UNITED STATES, 1919

	Mills making			
	Pulp only	Paper only	Both pulp and paper	Total
Number establishments ..	61	497	171	729
Capital.... . .	$42,081,327	$363,382,919	$500,330,337	$905,794,583
Value of products	$35,884,802	$374,362,194	$377,812,081	$788,059,377
Persons engaged....	6,309	56,796	61,830	124,935
Salaries and wages..	$7,591,403	$72,985,153	$85,066,830	$165,643,386
Wage earners	5,807	51,043	56,909	113,759
Wages .	$6,524,555	$58,324,653	$70,841,434	$135,690,642
Primary horsepower	143,371	561,698	1,145,945	1,851,014

Table 2

RAW MATERIALS USED IN THE MANUFACTURE OF PAPER IN THE UNITED STATES, 1919–1879

	1919 (tons)	1909 (tons)	1899 (tons)	1889 (tons)	1879 (tons)
Woodpulp purchased	1,595,980	1,241,914	644,006	349,917	(a)
Rags..............	277,849	357,470	234,514	246,892	200,005
Paper stock........	1,854,386	983,882	356,193	139,061	87,840
Manila stock:					
Rope............	68,235	117,080	99,301	524,862	84,786
Jute bagging.....	48,759				
Straw.............	353,399	303,137	367,305	355,131	245,838
Other stock........	106,850	29,422	(a)	(a)	1,218
China clay.........	258,533	(a)	(a)	49,616	(a)
Bleaching powder...	139,914	(a)	(a)	(a)	(a)
Sulphur............	187,794	(a)	(a)	(a)	(a)

(a) Not reported separately.

Table 3

THE WOOD PULP INDUSTRY IN THE UNITED STATES

	Rated capacity (tons)			
	1919	1914	1909	1904
Groundwood	1,975,039	1,789,363	1,809,685	1,515,088
Sulphite	1,656,066	1,341,622	1,250,983	885,092
Soda	464,482	499,325	344,953	244,573
Sulphate	252,995	77,820		

Table 4

PRODUCTION OF WOOD PULP IN THE UNITED STATES (TONS)

Year	Total	Mechanical	Sulphite	Soda	Sulphate
1870	1,077				
1880	22,570				
1890	305,544				
1899	1,179,525	586,374	416,037	177,114	
1904	1,921,768	968,976	756,022	196,770	
1905	2,084,482				
1906(a)	2,327,844				
1907	2,547,879				
1908	2,118,947				
1909	2,495,523	1,179,266	1,017,631	298,626	
1910	2,533,976				
1911	2,686,134				
1912					
1913					
1914	2,893,150	1,293,661	1,151,327	347,928	52,641
1915					
1916	3,435,001	1,508,139	1,466,402	387,021	73,439
1917	3,509,939	1,535,953	1,451,757	437,430	84,799
1918	3,313,861	1,364,504	1,456,633	350,362	142,362
1919	3,517,952	1,518,829	1,419,829	411,693	120,378
1920	3,821,704	1,583,914	1,585,834	463,305	188,651
1921	2,875,601	1,267,382	1,166,926	300,533	140,760
1922	3,521,644	1,483,787	1,374,319	419,857	243,681

(a) Estimated.

NOTE.—Wood pulp manufacture first appeared as an industry in the United States Census reports of 1870 with 8 establishments and a product valued at $172,350. In 1890, 225,437 tons of mechanical pulp, 71,639 tons of soda pulp and 52,841 tons of sulphite pulp, 349,917 in all, were reported as used in the manufacture of paper.

Table 5

WOOD PULP IN THE UNITED STATES

Year	Produced (tons)	Net imports (tons)	Available for consumption	
			Total amount (tons)	Per cent imported
1899	1,179,525	54,824	1,234,349	6
1904	1,921,768	169,238	2,091,006	8
1906	2,327,844	185,569	2,513,413	8
1908	2,118,947	239,188	2,358,135	10
1910	2,533,976	498,414	3,032,390	16
1912	....	525,961	....	....
1914	2,893,150	663,228	3,556,378	19
1916	3,435,001	643,742	4,078,743	16
1918	3,313,861	555,885	3,869,746	14
1920	3,821,704	874,164	4,695,868	19
1922	3,521,644	1,234,601	4,756,105	26

DIRECTOR OF INDUSTRIES. LIBRARY. 21 JUL 1924 BENGAL.

Table 6

Consumption of Wood Pulp in the United States (Tons)

Year	Production	Imports	Exports	Available for consumption
1870	(a) 1,077	....	....	....
1880	(a) 22,570	....	....	....
1890	(a) 305,544	44,373	....	349,917
1899	1,179,525	79,764	24,940	1,234,349
1902	....	107,698	15,669	....
1903	....	150,576	15,276	....
1904	1,921,768	179,324	10,086	2,091,006
1905	(a) 2,084,482	170,867	13,190	2,242,159
1906	(a) 2,327,844	199,702	14,133	2,513,413
1907	2,547,879	296,778	12,419	2,832,238
1908	2,118,947	250,485	11,297	2,358,135
1909	2,495,523	367,650	8,953	2,854,220
1910	2,533,976	506,775	8,361	3,032,390
1911	2,686,134	562,425	9,494	3,239,065
1912	....	540,150	14,189	....
1913	....	541,455	19,776	....
1914	2,893,150	675,565	12,337	3,556,378
1915	....	568,379	20,294	....
1916	3,435,001	683,765	40,023	4,078,743
1917	3,509,939	677,841	39,180	4,148,600
1918	3,313,861	578,209	22,324	3,869,746
1919	3,517,952	636,016	40,057	4,113,911
1920	3,821,704	906,297	32,133	4,695,868
1921	2,875,601	697,100	28,483	3,544,218
1922	3,521,644	1,259,638	24,500	4,756,105

(a) Estimated.

Table 7

Imports of Wood Pulp into the United States (Short Tons)

Year	From Canada	From Sweden	From Norway	From Finland	From Germany	From other	Total
1905	146,285	10,455	19,313	. . . .	7,833	3,718	187,604
1906	130,209	12,341	19,926	. .	9,545	4,070	176,091
1907	167,806	13,767	28,483		19,425	9,202	238,683
1908	162,243	30,279	21,326		38,875	13,292	266,015
1909	164,404	41,939	38,169	. . .	49,236	13,354	307,102
1910	206,183	52,775	62,584	.	79,207	22,976	423,725
1911	288,489	77,303	76,999	4,832	78,496	24,773	550,892
1912	234,435	119,307	83,049	4,912	73,515	19,591	534,809
1913	231,939	141,958	94,976	2,850	75,791	15,799	563,313
1914	262,126	132,729	90,628	1,359	74,586	7,883	569,311
1915	330,328	175,092	100,467	4,058	41,560	6,968	658,473
1916	395,499	112,778	57,989	896	119	413	567,894
1917	496,309	234,321	39,979		.	2,760	773,369
1918	569,050	784	5,750	.		2,624	578,208
1919	516,759	85,579	12,509	15,327		5,842	636,016
1920	654,678	156,518	34,259	42,599	8,875	9,369	906,298
1921	402,845	168,471	39,922	56,355	20,221	9,274	697,088
1922	645,414	409,476	95,621	68,442	28,058	12,627	1,259,638
Total	6,005,001	1,976,072	921,949	201,630	605,342	184,535	9,894,529

Table 8

IMPORTS OF GROUNDWOOD INTO THE UNITED STATES (SHORT TONS)

Year	From Canada	From Sweden	From Norway	From Finland	From other	Total
1909	124,916	....	5,099	....	125	130,140
1910	158,783	241	235	....	415	159,674
1911	250,998	2,897	2,696	....	6,910	263,501
1912	188,524	12,395	9,477	....	5,537	215,933
1913	175,697	3,058	875	....	5,816	185,446
1914	176,169	650	366	....	271	177,456
1915	208,254	155	....	....	1,315	209,724
1916	208,227	364	128	....	56	208,775
1917	285,608	2,464	12,156	....	2,292	302,520
1918	183,877	....	....	....	1,600	185,477
1919	198,881	....	....	....	3,372	202,253
1920	197,833	7,830	11,384	12,815	3,286	233,148
1921	137,362	15,555	23,381	13,698	747	190,743
1922	190,079	6,367	9,227	4,975	4,931	215,579
Total	2,685,208	51,976	75,024	31,488	36,673	2,880,369

Table 9

IMPORTS OF SULPHITE PULP INTO THE UNITED STATES (SHORT TONS)

Year	From Canada		From Sweden		From Norway		From other		Total	
	Bleached	Unbleached	Bleached	Un-bleached	Bleached	Un-bleached	Bleached	Un-bleached	Bleached	Un-bleached
1917 .	10,340	119,623	15,734	186,361	22,592	9,293	. . . .	142	48,666	315,419
1918 .	14,889	252,170	112	672	1,344	. . . .	412	612	16,757	253,454
1919 .	30,388	165,390	5,327	55,982	5,886	3,733	1,154	14,847	42,755	293,952
1920 .	96,382	232,587	7,603	82,832	15,047	4,062	9,175	25,488	128,207	344,969
1921 .	66,302	98,685	6,462	81,838	9,162	3,513	13,279	49,028	95,205	233,064
1922 . . .	137,003	164,291	46,052	221,798	43,852	32,630	14,170	54,706	241,077	473,425
Total . .	355,304	1,032,746	81,290	629,483	97,883	53,231	38,190	144,868	572,667	1,860,328
Grand Total . .	1,388,050		710,773		151,114		183,013		2,432,950	

Table 10

IMPORTS OF SULPHATE PULP INTO THE UNITED STATES (SHORT TONS)

Year	From Canada	From Sweden	From Finland	From other	Total
1917	80,738	29,762	...	6,264	116,764
1918	118,114	...	...	4,406	122,520
1919	122,100	24,270	430	4,256	151,056
1920	127,876	58,253	8,694	5,151	199,974
1921	100,496	64,626	6,495	6,470	178,087
1922	154,041	135,259	26,019	12,835	328,154
Total	703,365	312,170	41,638	39,382	1,096,555

Table 11

PULPWOOD USED IN THE UNITED STATES (CORDS)

Year	Total	Domestic	Imported
1870	2,200	...	...
1880	41,000	...	...
1890	583,200	...	...
1899	1,986,310	1,617,093	369,217
1904	3,050,717	2,473,094	573,618
1905	3,192,223	2,546,795	645,428
1906	3,661,176	2,922,304	738,872
1907	3,962,660	3,037,287	925,373
1908	3,346,953	2,651,817	695,136
1909	4,001,607	3,207,653	793,954
1910	4,094,306	3,146,540	947,766
1911	4,328,052	3,390,382	937,670
1912	...	...	...
1913	...	...	...
1914	4,470,763	3,641,063	829,700
1915	...	...	...
1916	5,228,558	4,444,565	783,993
1917	5,480,075	4,706,327	773,748
1918	5,250,794	4,506,276	744,518
1919	5,477,832	4,445,817	1,032,015
1920	6,114,072	5,014,513	1,099,559
1921	4,557,179	3,740,406	816,773
1922	5,548,842	4,498,808	1,050,034

Table 12

PULPWOOD USED IN THE UNITED STATES
BY PROCESSES (CORDS)

Year	Total	Mechanical	Sulphite	Soda	Sulphate
1870 (a)	2,200				
1880 (a)	41,000				
1890 (a)	583,200				
1899 (a)	1,986,310				
1904 (a)	3,050,717				
1905	3,192,123	1,096,794	1,630,393	464,936	
1906	3,661,176	1,197,780	1,958,619	504,777	
1907	3,962,660	1,361,302	2,059,496	541,862	
1908	3,346,953	1,117,428	1,739,282	490,243	
1909	4,001,607	1,246,121	2,145,984	571,502	38,000
1910	4,094,306	1,180,598	2,247,693	655,827	10,188
1911	4,328,052	1,314,141	2,342,550	642,680	28,681
1912 (b)	.....				
1913 (b)	....				
1914 (a)	4,470,763				
1915 (b)	....				
1916	5,228,558	1,524,386	2,856,122	707,419	140,631
1917	5,480,075	1,553,633	2,892,322	843,048	191,072
1918	5,250,794	1,345,435	2,860,172	748,638	296,549
1919	5,477,832	1,536,447	2,866,603	802,186	272,596
1920	6,114,072	1,591,378	3,202,380	923,695	396,619
1921	4,557,179	1,287,095	2,367,919	610,059	292,106
1922	5,548,842	1,494,027	2,765,279	786,968	502,568

(a) Detailed data not available.
(b) No data available.

Table 13

Pulpwood Consumption in the United States by Species (Cords)

Year	Total	Spruce and balsam fir	Hemlock	Poplar	(a) Pine	Cotton-wood	Gum	Beech, birch and maple	Miscel-laneous
1899	1,986,310	(c) 1,509,202	(d)	256,953	(d)	(d)	(d)	(d)	220,150
1904	3,050,717	(c) 2,270,836	(d)	248,371	(d)	(d)	(d)	(d)	531,515
1905	3,192,123	2,329,998	375,422	322,058	57,399	10,507	(d)	(d)	96,739
1906	3,661,176	2,540,888	528,381	328,470	69,277	(d)	(d)	(d)	194,160
1907	3,962,660	2,744,737	576,154	371,940	78,583	66,084	(d)	(d)	125,162
1908	3,346,953	2,205,148	569,173	302,217	84,189	45,679	(d)	(d)	140,547
1909	4,001,607	2,516,947	559,657	328,498	90,885	36,898	(d)	(f) 31,390	437,332
1910	4,094,306	2,508,311	610,478	361,076	105,882	31,099	(d)	(f) 44,265	433,195
1911	4,328,052	2,707,509	616,663	368,224	124,019	25,043	(d)	(g) 81,299	405,295
1912 (h)	....	....	....	....	....	....	....	....	....
1913 (h)	....	....	....	....	....	....	....	....	....
1914	4,470,763	2,786,091	602,754	390,157	141,359	18,176	11,935	(d)	520,291
1915 (h)	....	....	....	....	....	....	....	....	....
1916	5,228,558	3,402,692	760,226	411,696	170,378	22,211	37,391	77,762	346,202
1917	5,480,075	3,449,452	775,003	406,253	217,476	32,993	32,513	(e) 183,317	383,068
1918	5,250,794	3,238,424	836,406	289,203	285,898	18,685	47,145	(e) 202,930	332,103
1919	5,477,832	3,476,028	795,154	338,380	286,044	20,830	30,355	(e) 183,426	347,615
1920	6,114,072	3,816,480	885,485	367,694	363,486	25,790	68,914	122,393	463,830
1921	4,557,179	2,741,619	863,043	268,609	280,817	21,674	18,235	(b) 91,403	271,779
1922	5,548,842	3,341,151	893,195	337,931	422,724	(d)	52,058	90,300	411,483

(a) Includes yellow and jack pine.
(b) Includes a small quantity of elm.
(c) Does not include balsam fir.
(d) Not stated separately.
(e) Includes chestnut.
(g) Does not include birch.

Table 14

PULPWOOD USED IN THE UNITED STATES BY REGIONS (CORDS)

Region	1904	1909	1916	1918	1920	1922
New England	1,086,209	1,370,835	1,785,109	1,725,682	1,965,839	1,647,867
New York	864,214	921,882	1,094,513	1,003,742	1,130,505	872,636
Pennsylvania	243,420	295,038	423,843	383,699	490,784	405,197
Lake States	497,968	756,238	1,136,021	1,246,375	1,462,606	1,512,451
Pacific Coast	57,001	104,021	259,544	239,774	334,193	346,261
All other	301,905	553,593	529,528	651,522	730,145	764,430
Total	3,050,717	4,001,607	5,228,558	5,250,794	6,114,072	5,548,842

Table 15

PULPWOOD USED IN THE UNITED STATES AND CANADA (CORDS)

	1908	1910	1912	1914	1916	1918	1920	1922
Canada	482,777	598,487	866,042	1,224,376	1,764,912	2,210,744	2,777,422	2,912,608
United States	3,346,953	4,094,306	4,300,000 (?)	4,047,763	5,228,558	5,250,794	6,114,072	5,548,842
Total	3,829,730	4,692,793	5,166,042	5,272,139	6,993,470	7,461,538	8,891,494	8,461,450

Table 16

THE PULP AND PAPER INDUSTRY IN CANADA

	1919	1921
Operating mills	99	100
Capital	$275,767,364	(b) $379,812,751
Value of products:		
Pulp made for sale	$48,485,746	$42,326,213
Paper made for sale	$91,362,913	$108,676,952
Employees (all classes)	26,647	24,611
Salaries and wages	$32,264,208	$34,199,090
Rated horsepower	(a) 623,588	987,984

(a) 78 per cent hydraulic and electric.

(b) Greatest increase between 1919 and 1921 in investments in land, buildings and machinery.

Table 17

PULP AND PAPER INDUSTRY IN CANADA
(Materials Used)

	1919 (tons)	1921 (tons)
Pulp	1,220,360	1,002,930
Rags	16,435	10,369
Old or waste paper	62,957	61,914
Straw	1,449	1,733
Manila stock, etc	1,990	....
Other fibers	15,841	24,399
Paper made all kinds	1,090,235	1,021,941
Fuel used:		
Coal, tons	1,213,089	1,251,341
Oil, gallons	14,397,318	4,559,928
Wood, cords	33,462	22,154
Total cost of fuel	10,549,493	12,500,643
Sulphur	78,993	66,971
Lime and limestone	121,447	121,540
Bleach	9,256	11,436
Sulphate and carbonate of soda, etc	27,756	32,920

Table 18

THE WOOD PULP INDUSTRY IN CANADA
Rated Capacity (tons)

	1921	1919
Groundwood	1,320,344	1,193,920
Sulphite	813,746	681,700
Sulphate	219,670	202,800
Soda	6,450	5,600

Table 19

PRODUCTION OF WOOD PULP IN CANADA (TONS.)

Year	Total	Mechanical	Sulphite	Sulphate	Soda
1908	363,079	278,570	82,331	....	2,178
1909	445,408	325,609	114,926	....	4,873
1910	474,604	370,195	95,987	....	8,422
1911	496,833	362,321	110,391	... .	24,121
1912	682,632	499,226	142,978	33,469	6,959
1913	854,624	600,216	183,552	68,284	2,572
1914	934,700	644,924	217,550	70,333	1,893
1915	1,074,805	743,776	235,474	92,405	3,150
1916	1,296,084	827,258	363,972	100,977	3,877
1917	1,464,308	923,731	374,894	161,547	4,136
1918	1,557,193	879,510	494,322	179,600	3,761
1919	1,716,089	990,902	562,115	158,475	4,597
1920	1,960,102	1,090,114	675,733	188,487	5,768
1921	1,549,082	931,560	481,984	131,337	4,201
1922	2,150,251	1,241,185	678,878	217,862	793

Table 20

CONSUMPTION OF WOOD PULP IN CANADA (TONS)

Year	Production	Exports	Imports	Available for consumption
1908	363,079	239,805	....	....
1909	445,408	280,744	....	....
1910	474,604	328,977	....	....
1911	496,833	259,514	....	....
1912	682,632	348,100	....	....
1913	854,624	298,169	....	....
1914	934,700	424,883	....	....
1915	1,074,805	364,170	....	....
1916	1,296,084	558,899	....	....
1917	1,464,308	511,803	....	....
1918	1,557,193	583,911	....	....
1919	1,716,089	709,129	13,076	1,020,036
1920	1,960,102	819,985	21,141	1,161,258
1921	1,549,082	527,222	17,354	1,039,214
1922	2,150,251	818,247	17,300	1,349,304

Table 21

PULPWOOD USED IN CANADA BY PROCESSES (CORDS)

Year	Total	Mechanical	Sulphite	Sulphate	Soda
1908	482,777	....	....	....	....
1909	622,129	....	....	....	....
1910	598,487	....	....	....	....
1911	672,288	408,000	230,000	....	45,000
1912	866,042	499,226	285,959	66,938	13,919
1913	1,109,034	600,216	367,105	136,569	5,144
1914	1,224,376	644,924	435,101	140,666	3,785
1915	1,405,836	743,776	470,949	184,811	6,300
1916	1,764,912	827,258	729,945	201,954	7,755
1917	2,104,334	964,479	855,489	274,646	9,720
1918	2,210,744	873,084	1,044,697	285,194	7,769
1919	2,428,706	1,010,457	1,127,659	281,360	9,230
1920	2,777,422	1,080,618	1,354,023	330,907	11,874
1921	2,180,578	967,519	982,296	222,175	8,588
1922	2,912,608	1,214,910	1,325,074	370,979	1,645

Table 22

PULPWOOD CONSUMPTION IN CANADA BY SPECIES (CORDS)

Year	Total	Spruce	Balsam fir	Hemlock	Poplar	Pine	Other
1908......	482,777	420,631	57,821	....	1,575	2,7[illegible]0	
1909.......	622,129	516,030	100,095	700	5,188		116
1910........	598,487	470,230	120,475	3,816	3,608		358
1911........	672,288	548,276	117,400	1,670	4,186		756
1912......	866,042	677,747	164,587	19,178	4,405	40	85
1913....	1,109,034	754,858	283,292	47,360	4,141	19,383	
1914........	1,224,376	836,387	314,183	45,246	3,845	24,715	
1915........	1,405,836	998,156	307,219	55,265	3,243	41,953	
1916...... ..	1,764,912	1,203,557	433,154	82,307	6,177	39,717	
1917........	2,104,334	1,678,656	309,515	101,321	5,168	2,850	6,824
1918........	2,210,744	1,638,733	447,243	89,007	9,885	25,851	25
1919........	2,428,706	1,787,868	490,327	118,013	7,228	15,402	9,868
1920........	2,777,422	1,873,024	687,519	176,029	5,732	15,743	19,375
1921........	2,180,578	1,409,478	511,791	122,907	3,557	40,406	2,349
1922........	2,912,608	2,032,985	627,626	157,947	1,305	79,461	13,284

Table 23

PULPWOOD USED IN CANADA BY PROVINCES (CORDS)

Year	Total	Quebec	Ontario	N. B.	B. C.	N. S.
1908.....	482,777	255,943	154,714	54,058	(1)	18,062
1909.....	622,129	319,935	187,352	88,450	1,316	25,076
1910. ...	598,487	342,755	210,552	22,634	440	22,106
1911.....	672,288	390,426	213,667	45,824	150	22,221
1912.. ..	866,042	578,855	173,903	52,041	35,067	26,176
1913.....	1,109,034	629,934	321,244	53,121	84,173	20,562
1914.	1,244,376	636,496	447,751	49,339	80,013	10,777
1915. . .	1,405,836	697,962	480,627	115,842	90,535	20,870
1916.	1,764,912	924,272	637,612	79,594	108,997	14,437
1917..	2,104,334	1,109,869	735,691	105,586	134,814	18,374
1918..	2,210,744	1,085,478	784,691	110,133	218,774	11,668
1919.....	2,428,706	1,176,134	840,856	140,607	250,358	20,751
1920.....	2,777,422	1,333,815	942,672	180,723	295,617	24,595
1921.....	2,180,578	1,111,277	700,589	121,110	225,240	22,362
1922.....	2,912,608	1,405,440	980,635	204,965	274,649	46,919

(1) No pulp was manufactured in British Columbia prior to 1909.

Table 24

Canadian Exports of Wood Pulp 1890–1908 Inclusive (Values Only)

Fiscal years	Great Britain	United States	Other countries	Total
1890	$ 460	$ 147,098	$ 20,622	$ 168,180
1891	....	280,619	....	280,619
1892	....	355,303	....	355,303
1893	1,640	454,253	....	455,893
1894	178,255	368,256	706	547,217
1895	251,848	336,385	2,641	590,874
1896	113,557	557,085	5,135	675,777
1897	164,138	576,720	1,101	741,959
1898	670,100	534,305	16	1,210,421
1899	671,704	578,229	24,343	1,274,276
1900	502,178	1,193,753	60,085	1,816,016
1901	934,722	937,330	65,155	1,937,207
1902	818,580	1,170,400	57,418	2,046,398
1903	1,129,173	1,795,768	226,002	3,150,943
1904	548,720	1,807,442	52,912	2,409,074
1905	680,199	2,694,122	24,837	3,399,158
1906	998,702	2,419,628	59,820	3,478,150
1907	558,609	2,397,448	28,888	2,984,945
1908	485,199	3,545,530	7,123	4,037,852
Total	$8,773,784	$22,149,674	$636,804	$31,560,262

Table 25

Canadian Exports of Pulpwood 1890–1908 Inclusive (Values Only)

Fiscal years	Great Britain	United States	Other countries	Total
1890	$ 22,808	$ 57,197		$ 80,005
1891	18,362	170,636		188,998
1892	36,146	183,312		219,458
1893	13,461	371,981	$ 650	380,092
1894	24,250	369,010	. .	393,260
1895	9,396	458,613	....	468,009
1896	27,580	600,285	....	627,865
1897	33,931	677,221	.....	711,152
1898	34,772	876,690	579	912,041
1899	28,099	809,795	4,192	842,086
1900	38,370	864,077	325	902,772
1901	32,198	1,364,821	.	1,397,019
1902	120,445	1,194,593	.	1,315,038
1903	. .	1,558,560		1,558,560
1904	......	1,788,049	.....	1,788,049
1905	....	2,600,814	......	2,600,814
1906	....	2,649,106	......	2,649,106
1907	....	1,998,805	.....	1,998,805
1908	....	4,665,371	....	4,655,371
Total	$439,818	$23,248,936	$5,746	$23,694,500

SAMPLE WORKING PLAN FOR ADIRONDACK SOFTWOODS[1]

By A. B. Recknagel, 1922. For the Working Period 1923–1932 Inclusive

1. *Foreword.*

This plan is prepared in accordance with the vote at the joint meeting of timberland owners and foresters in New York City on June 7, 1922, "that a sample working plan . . . be prepared . . . for the purpose of illustrating and of explaining what is intended under 'Regulation of Cut.'"

Through the courtesy of Finch, Pruyn & Co. it is possible to use the data gathered by Messrs. H. L. Churchill and T. H. Crawshaw on a typical area of softwood land (Spruce Flat Type) on the upper Hudson in Essex County. These data were supplemented by a study of growth of spruce and balsam following early cutting for sawtimber.[2]

The outline followed is one prepared for use by timberland owners in New York State, particularly in the Adirondacks.

2. *Introduction.*

(a) This tract is located west of the Hudson River and east of lands of R. C. Pruyn, in Townships 46 and 47, and the Hyslop Patent, Totten and Crossfield's Purchase, in the Town of Newcomb, County of Essex, State of New York.

(b) The area covered by this plan is as follows:

	Acres
South water shed, Santanoni—Sucker Brook.	2,862
Upper Beaver Brook and tributaries	1,157
Lower Beaver Brook...... . . .	1,714
Along Hudson River...... . .	267
Total acres................ . ..	6,000

(c) Previous to its acquisition by Finch, Pruyn & Co., Inc., the area belonged to the McIntyre Iron Co. It was last logged in 1892 for softwood saw timber to about 10 inches in diameter on the stump.

(d) The village of Newcomb is near by and furnishes a fair supply of skilled woods labor. Additional help can be obtained from Tupper Lake.

(e) The saw timber and pulpwood is driven down the Hudson and its tributaries to the paper mill and sawmill of the company at Glens Falls. Thus none of the forest products are consumed locally.

---

[1] Reprinted from *Bulletin* 15 of the Empire State Forests Products Assn., October, 1922.

[2] See "Growth of Spruce and Balsam in the Adirondacks" paper read at meeting of N. Y. Section, Society of American Foresters, August 16, 1922, and published in *Journal of Forestry.*

3. *The Forest.*

(a) This area is all in the spruce flat type.

(b) The entire area is cut over but restocking satisfactorily with young growth of *softwoods*. (See Forest Description in the Appendix.)

(c) *Stand Table.*—The following stand table is based on the careful measurement of an average acre and shows the number of trees of each kind by diameters at breast height (4½ feet above ground):

TABLE 1.—STAND TABLE FOR AVERAGE ACRE

Spruce Flat Type Cut 30 Years Ago to About 10 in. Diameter on Stump

D. B. H. Ins.	Spruce	Balsam	Hemlock	Cedar	Beech	Yel. Birch	Hd. Map.	Misc.	Total
1	22	......	......	......	7	5	......	17	51
2	21	1	1	1	1	8	......	18	51
3	8	1	1	1	1	12	......	10	34
4	11	5	......	2	......	6	......	12	36
5	5	7	......	2	1	4	......	6	25
6	5	3	......	3	4	12	......	9	36
7	7	3	1	......	3	8	......	7	29
8	3	8	......	......	5	4	1	4	25
9	9	3	1	......	1	3	......	1	18
10	8	12	......	......	1	2	......	5	28
11	7	10	2	....	2	2	......	1	24
12	9	4	......	......	1	2	......	......	16
13	7	6	3	......	1	......	......	......	17
14	......	4	2	......	1	2	......	1	10
15	......	......	......	......	......	......	......	1	1
16	......	1	1	......	......	......	......	......	2
17	......	......	......	......	......	2	......	......	2
18	......	1	......	......	......	1	......	1	3
19	......	......	......	......	......	1	......	......	1
20	......	......	1	......	......	1	......	......	2
21	......	......	1	......	......	1	......	......	2
22	......	......	......	......	......	1	......	......	1
23	......	......	......	......	......	1	......	......	1
Total trees per acre	......	......	......	......	......	......	......	......	415

(d) *Stock Table.*—The following table shows for the same average acre (as in Table 1) the volumes in cubic feet for spruce and balsam and board feet for hemlock and hardwoods (omitting the Cedar, which is of inconsiderable size). Local volume tables were prepared for spruce and balsam based on Cary: "Manual for Northern Woodsmen," Table 6 (see Appendix); for hemlock and hardwoods the volumes were those obtained by field measurements in St. Lawrence County. These tables show no values for beech under 10 inches or for birch and maple under 11 inches d. b. h. This explains why no values for maple are given in the stock table. For the miscellaneous species (black ash, black cherry, striped maple) the volume table for yellow birch was used as being the most conservative. Cubic feet are converted into cords at a ratio of 90 cubic feet per cord.

(e) The current annual increment per cents used in determining the yearly growth of spruce and balsam are the result of careful local studies on the adjacent estate of R. C. Pruyn, Esq., now being cut over.[1] The hemlock and the hardwoods are omitted in the following calculations since the growth of spruce and balsam is the chief consideration, since no local data are available on the growth of hemlock and hardwoods and since it may be assumed that these species are largely at a standstill because of over-maturity and decay, there having been no cutting except for softwoods.

TABLE 2.—STOCK TABLE FOR AVERAGE ACRE
Spruce Flat Type Cut 30 Years Ago to 10 in. Diameter on Stump

D.B.H. Ins.	Spruce Cu. Ft.	Balsam Cu. Ft.	Total Cu. Ft.	Hemlock Bd. Ft.	Beech Bd Ft.	Yel. birch Bd. Ft.	Misc Bd Ft.	Total Bd. Ft.
5	18.5	29.4	47 9	.	.	. .		. ..
6	24 5	18 6	43 1	.		.	..	. ..
7	44 1	27.3	71 4	5	..	. .	.	5
8	25 8	91 2	117 0	..	.	.	.. .	. .
9	108 0	48 3	156 3	14	.	. .	.	14
10	132.0	228 0	360 0	.	48	. .	.	48
11	137 9	237 0	374 9	84	120	90	45	339
12	225 0	110 0	335 0		83	132	.	215
13	203.0	205 2	408 2	213	103	.	.	316
14	.	155 6	155 6	190	130	206	103	629
15	.. .	. .	.	.	. ..	.. .	125	125
16	.	52 2	52 2	145	.	.	....	145
17	...	.		.	.	344	. ..	344
18	...	63 6	63 6	..	. .	198	198	396
19	.	.	.	.	. .	227	.....	227
20	..	.	.	295	.	255	....	550
21	. .	. .	.	330	.	290	...	620
22	. .	.	.	.	.	322	. .	322
23	..	..	.		.	359	.	359
TOTAL	918.8 cu. ft. 10.21 cords	1,266.4 cu. ft. 14 07 cords	2,185 2 cu. ft. 24 28 cords	1,276 bd. ft.	484 bd. ft.	2,423 bd. ft.	471 bd. ft.	4,654 bd. ft.

Churchill, in memorandum of May 29, 1922, figures that "the direct loss due to lumbering in smaller trees left on the areas logged, is about 20 per

---

[1] See "Growth of Spruce and Balsam in the Adirondacks" paper read at meeting of Association and article referred to in the "Foreword" above.

TABLE 3.—CURRENT ANNUAL INCREMENT OF SPRUCE AND BALSAM

For Average Acre of Spruce Flat Type

D. B. H. Inches	5	6	7	8	9	10	11	12	13	14	Total
Current annual increment per cent (spruce).	4.2	4.05	3.9	3.8	3.7	3.6	3.4	3.3	3.1	3.0	
C. A. I. cu. ft. . .	.7770	.9922	1.7199	.9804	3.9960	4.7520	4.6886	7.4450	6.2930		31.6441 cu. ft. .3516 cords =3.44%
Current annual increment per cent (balsam)	4.6	4.5	4.4	4.3	4.2	4.0	3.8	3.6	3.4	3.1	
C. A. I. cu. ft. . .	1.3524	.8370	1.2012	3.9216	2.0286	9.1200	9.0060	3.9600	6.9768	4.8236	43.2272 .4803 cords =3.41%

cent of the volume, and there is a certain amount of loss annually due to windfall, disease, and insects, which amounts to perhaps 1 per cent yearly of the volume standing for twenty years after cutting."

This factor has been used in the calculations which follow. The increment of balsam above 14 inches has been omitted as being offset by the decay which is common in balsams of larger size.

These figures for annual growth must be reduced 20 per cent for mortality in logging and 1 per cent annually for loss by windfall, disease and insects. Since the planned cuttings extend over 20 years (see below) the reduction is 2 per cent per annum, or a net increment of .3446 cords of spruce, .4707 cords of balsam = .8153 cords annual growth which is 3.36 per cent of total cords of standing spruce and balsam as given in Table 2.

(f) The total estimate of standing timber on the tract is obtained by multiplying the values in Table 2 by the acreage (6,000 acres) of the tract. The annual growth for spruce and balsam on the entire tract is derived from Table 3.

TABLE 4.—SUMMARY OF ESTIMATES AND GROWTH

For 6,000 Acres of Spruce Flat Type

Species	Standing timber	Annual growth
Spruce	61,260 cords	2,068 cords
Balsam	84,420 cords	2,824 cords
Total	145,680 cords	4,892 cords
Hemlock	7,656,000 bd. ft.	Not ascertained
Beech	2,904,000 bd. ft.	Not ascertained
Yellow birch	14,538,000 bd. ft.	Not ascertained
Miscellaneous	2,826,000 bd. ft.	Not ascertained
Total	27,924,000 bd. ft.	Not ascertained

4. *Proposed Management.*

(a) *Object of Management.*—The company owning the tract desires continuous forest production thereon so far as possible, the yield should be sustained *not* annually but periodically, with pulpwood as the chief crop.

(b) *Practical Restrictions.*—The chief difficulty in handling the tract for continuous crops of pulpwood is the cost of logging. The annual cut must be of sufficient volume to justify the expense of roads, camps, logging equipment, etc. This means that the period of return for a second cut on the same area must be longer than is desirable for the good of the forest. Management, then, is a compromise between the necessities of logging and what is the best forestry practice. As the years pass, the balance will swing towards better forestry practice because of the increasing value of the stumpage.

This is why no cutting of hardwoods is planned for the ensuing working period (1923–1932). Present utilization of hardwoods is not compatible with the best forestry practice. Pulpwood utilization, on the other hand, is complete, taking everything to a 3-inch diameter in the top and where 4-foot wood is cut and peeled there is practically no waste.

(c) *Method of Cutting.*—A selection system of cutting is advised for spruce and balsam on this tract. As Churchill said in a working plan for similar lands belonging to the Company in 1912:

"The only way to get satisfactory results in this work is to mark all trees to be cut and upon the skill with which this marking is done depends in a very large measure the success of the work.

"Except where absolutely needed for seeding, all trees that have reached their limit of effective growth should be cut regardless of size. Also all trees with broken or suppressed crowns or injured by fire or otherwise so that they are likely to become defective before the next cutting. The trees left should be sound, wind-firm and have well-developed crowns. They should be trees that will live and add a substantial growth to their volume each year until the next cut.

"A careful study of existing conditions upon all parts of these holdings has conclusively shown that the best results cannot be obtained by cutting to a fixed diameter limit, but that the cutting must be made to conform to conditions existing upon each area logged."

In general, balsam should be cut heavily, especially the tall, spindly trees which are prone to windfall, and spruce should be cut more lightly, leaving short stocky trees with well-developed crowns that have adequate growing space and are not in danger of suppression by the hardwoods.

As an approximate diameter limit, spruce should be cut down to and including 10 inches d.b.h. and balsam down to 5 inches d.b.h., since balsam is sure to reproduce anyway and its heavier cutting will favor the reproduction of spruce and also because balsam is prone to windfall.

However, in the marking, no rigid diameter limits should be observed, but the conditions on the ground should govern in the choice of trees to be taken, remembering that a second cut is to be made 20 years hence and leaving a sufficient stand of thrifty trees to make this possible.

(d) A cutting cycle (period between cuts) of 20 years is recommended. The rotation (total age at which trees are to be cut) is tentatively set at 80 years. At that age both spruce and balsam have attained pulpwood size.

5. *Regulation of Cut.*

(a) The paper mill of the company requires 30,000 cords of pulpwood annually. Only a part of this need come from the tract in question since the company has other holdings. It is expected, however, to get as much pulpwood from this tract as is compatible with maintaining its productivity unimpaired—that is, with a sustained periodic yield.

(b) This means that the crop 20 years hence must be adequate to warrant logging the area for a second cut. The growth of the trees left must be the source of this second cut. To ensure this requires a regulation of the present cut which has been figured by various methods as follows: (For details of computations, see Appendix.)

(c) The allowed annual cut by four different methods for an average acre is as follows:

Method	Spruce	Balsam	Total
1. Chapman[1]..	4907	8956	1 3863
2. Heyer[2].	4103	9388	1 3491
3. Von Mantel[2]..	2550	3520	6070
4. Jackson[3]	6828	9388	1 6216

[1] See WOOLSEY, T. S., JR.: "American Forest Regulation," where this method is summarized in Articles 127, 138 and 144.

[2] See RECKNAGEL and BENTLEY. "Forest Management " P 148

[3] See JACKSON: "A Short Manual of Forest Management " P. 58.

Von Mantel's method is always conservative; Heyer's and Chapman's and Jackson's agree closely, so the values derived by Chapman's method may be accepted. This is especially desirable because the method is well adapted to this kind of a forest.

(d) *The calculated cut,* then, for spruce and balsam on the entire tract for the ensuing 10-year working period is as follows:

Species	Per annum	For 10-year working period
Spruce................	2,944 2 cords	29,442 cords
Balsam.............	5,373 6 cords	53,736 cords
Total....	8,317 8 cords	83,178 cords

For the 10-year working period the cut should not, therefore, exceed, in round numbers, 83,000 cords of spruce and balsam. Assuming that the company desires a cut of 12,000 cords a year or 120,000 cords in the ten-year period, this would exceed the allowed cut by 37,000 cords and seriously encroach on the growing stock inasmuch as there are only 28,533 cords of spruce above the suggested diameter limit and 84,420 cords of balsam, making a total of 112,953 cords.

It would be better, therefore, to curtail the cut from this tract to 10,000 cords yearly and to cease cutting after 8 years in order to resume again at the eleventh year with a normal cut of 8,300 cords. This is the best way of maintaining the productivity of the tract unimpaired.

(e) *Allocation of Cut.*—The areas listed in 2 (b) as composing this tract should preferably be cut in the following order:

	Acres
1. Along Hudson River	267
2. South watershed, Santanoni—Sucker Brook	2,862
3. Upper Beaver Brook and Tributaries	1,157
4. Lower Beaver Brook	1,714
Total	6,000

Each year's cutting should be selected in advance and the trees thereon marked for cutting by the company's forester. The cost of this is estimated at 8 to 10 cents per M. ft. or 4 to 5 cents per cord.

6. *Fire Prevention.*

(a) Overlooking this tract, there are two lookout stations maintained by the Conservation Commission from which fires are promptly reported to the local ranger. These are Mt. Adams (east of the "Upper Works") and Goodenow Mt. (south of the state road, west of Newcomb).

(b) Under the law all softwood tops have to be lopped to a diameter of 3 inches, which coincides with commercial practice in the cutting of pulpwood. The company already patrols its land—three men are so employed —and this patrol will be extended to the tract in question, particularly to cut-over areas. The company posts its lands against trespass[1] and requires permits from all who wish to hunt or fish on its lands.

(c) Cooperation in fire prevention on this tract should be had with the adjacent owners—R. C. Pruyn of Albany and the Tahawus Club and the McIntyre Iron Co. as well as with the State of New York. Especially dangerous for the next working period is the recent softwood slash on the Pruyn tract and a joint patrol of this portion of the forest might be arranged, each owner paying a proportionate share for its maintenance. Patrol must be specially careful in the 3 or 4 years following the cutting.

(d) The chief need on this tract is to make all parts of it readily accessible in case of fire. This requires a system of permanent trails over which men and equipment can be moved with due rapidity. As logging proceeds, the main hauling roads and the tote roads will penetrate all parts of the tract. Certain of these roads should be kept clear and in shape as permanent trails.

---

[1] For use on recently cut-over lands it would be better if the notices were prepared by, and issued under the authority of, the Conservation Commission.

Wherever the area is heavily lumbered and there are dangerous accumulations of inflammable material the trails should be posted at frequent intervals with fire warnings.[1]

(e) Men to fight fire can be obtained from Newcomb and other nearby points, but they will need tools. Therefore, fire-fighting apparatus and equipment should be purchased as needed in view of materials which the company already owns. Some tools may be left in locked boxes at convenient points and a central supply maintained for the rest. The purchase of a gasoline pump for fire fighting is recommended. Arrangements should be made for the hire of a truck or other suitable means of transportation in case of emergency.

7. *Protection Against Insects and Disease.*

The apparent insect danger on this tract is slight. Damage to spruce and beech from heart rot caused by fungi is common, but should diminish with the cutting of the ripe timber which is most subject to attack. Forest sanitation, in general, will improve with the removal of the mature and over-mature timber and with adequate fire prevention.

8. *Special Problems.*

None covered in this plan.

9. *Appendix.*

The following tables of volume and growth are included in the Appendix:

Table A. Local volume table for spruce and balsam.

Table B. St. Lawrence Co. volume table for hardwoods.

Table C. Current annual increment of spruce and balsam.

Table D. Years to grow one inch in diameter for spruce and balsam.

NOTE.—In order to economize space, the Appendix has not been printed.

TECHNICAL OUTLINE RE FOREST SURVEYS AND WORKING PLANS

PROVINCE OF QUEBEC

DEPARTMENT OF LANDS AND FORESTS

FOREST SERVICE

1. PERIMETER

1. The boundary lines of the forest tracts should be traversed and blazed as requested by the Quebec Forest Service.

2. BASE LINE

2. A base line, made with the transit or the surveyor's compass, must be used as initial departure of each strip survey or line of estimation.

---

[1] Under these conditions Col. Graves has suggested "to dispose of the slash for a space of about 50 feet on each side of the trails . . . This should be done by piling and burning. If the piling is done at the time of logging, the cost would not exceed 50 cents per M. ft. of timber cut along the strip."

3. Such base line must be cleaned, blazed and chained; pickets must be planted or other indications made at every quarter of a mile.

4. The streams may be used as base line, provided they are surveyed as indicated above.

3. STRIP SURVEYS

5. These lines must be run as much as practical in a direction perpendicular to the base line.

6. The strips should be parallel and not more distant than 30 chains, except when the land is very swampy or covered by muskegs or with recent burns: in such cases the equidistance between two consecutive strips may be equal to a mile.

7. When a river is used as base line, the strip surveys must have a direction perpendicular to the general trend of the stream.

8. The strips must have a minimum of 33 ft. in width.

9. The sheets used for the estimation must be changed whenever there is a real change of forest type, and should the stand remain uniform in character, then the sheets can be changed only at every quarter of a mile.

10. It will be necessary to note, in the course of this work, all the changes in topography, such as slopes, streams, lakes, etc., and to indicate them faithfully on the plans.

11. A minimum of at least 1 per cent of the total area of the forest inventoried must be covered by the strip surveys.

12. It is necessary to determine, with as much accuracy as practical, the boundaries and the area of each forest type.

4. SAMPLE PLOTS

13. The sample plot method can be used, provided the plots are selected on lines which are run under the same principle as the strip surveys.

14. The sample plots must be of at least half an acre in area, and should be located at least at every thirty chains' interval.

15. The stand found between two sample plots will be calculated by ocular estimate, and such estimate to be corrected by the values found on the respective sample plots.

16. The other information requested by the strip survey method must also be furnished by this method of estimation.

5. FOREST TYPES

17. The general forest types which we recommend are as follows:

(a) Hardwoods-Conifers: More than 50 per cent hardwoods;
(b) Conifers-Hardwoods: More than 50 per cent conifers;
(c) *Conifers:* If 75 per cent of conifers and more;
Subtypes: White spruce, black spruce, red spruce, balsam, white pine, red pine, gray pine, tamarack, hemlock, arbor vitae or white cedar, etc.
(d) *Hardwoods:* If 75 per cent of hardwoods and more.

Subtypes: Maple, yellow birch, white birch, canoe birch, aspen, poplar, basswood, beech, etc.

18. Please do not forget to give, in each case, the approximate average age of the stand.

6. VOLUME TABLES

19. Prepare one in the field, for each species, based upon the diameter, and taking all wood up to 4 inches in the tops, allowing one foot for the stump;

20. Use the cubic foot for all your estimates.

7. QUALITIES OF THE STATION

21. The qualities of the station must be based upon the height of the trees, the fertility of the soil, etc. We suggest to use the following qualifications:

(a) Excellent; (b) average; (c) poor; (d) bad

8. GROWTH STUDIES

22. The choice of every sample tree must be made with precaution as each one must be typical of the stand.

23. The number of sample trees to be studied depends upon the importance of the forest types, and, for the diameter classes forming the bulk of the stand, not less than five sample trees should be used.

24. Methods of study must be based upon· 1°. Complete studies of the different sections of the tree; 2°. Partial analysis of the growth at a given point of tree, such as "D. B. H.," diameter on the stump, diameter at the middle height of the tree, etc.

25. Counting and writing the decades: 1°. From center to the bark; 2°. From bark to the center.

26. A study of the time necessary for the increase of the last inch in radius or in diameter.

27. Determination of the percentage of increment of the volume of the tree at the different periods of its life.

28. Calculation of the time necessary for the passing from one diameter class to the following class (stump analysis, etc.).

29. Interpolation of the results.

30. Please use the square of the diameters for the calculation of your values by curves, instead of the ordinary diameter, so as to get thereby functions of the first degree (straight lines) instead of functions of the second degree (curves) as the result of your interpolation.

31. Estimate of the basal area of the tree at the different decades.

32. Calculation of the basal area of the stand.

9. CALCULATION OF THE VOLUME AND YIELD OF THE STANDS

33. Calculation of the area of the various forest types in each basin.

34. Calculation of the average volume per acre of each forest type.

35. Calculation of the total volume of each forest type in a given basin.

36. Calculation of the total volume and yield of all the forest stands by individual basin.

10. EXPERIMENTAL PLOTS OR CONTROL AREAS

37. These control areas must be selected during the inventory work, or in the course of the growth studies. We need them to enable us to follow the effects of the experiments made with various methods of treatment. The boundaries of each plot must be well blazed. These areas must be typical of the general conditions of each type; they must also be easy of access and not seriously exposed to the danger of forest fires. They must not be selected only in the old forest, but in the younger stands, so as to cover every age class and reproduction.

11. PLANS AND MAPS

38. Please distinguish between each forest type by means of conventional colors and symbols.

39. Indicate on the plan by their respective numbers the strip surveys, or sample plots, showing their proper locations and directions.

40. Indicate, by the proper symbols, the volume of the various stands.

41. Scale. For the general plan: One mile to the inch; for the details plans: One-quarter mile to an inch. We must aim to have, as much as possible, sheets of a uniform size, say, 20 by 40 ins., with a border of 5 ins.; thus the sheets should measure 25 by 45 ins.

12. REPORT

42. General description of the land: Situation, geography, geology, climate, etc.

43. General description of the forest and of the forest types, giving their distribution, composition, origin, evolution, reproduction and relative importance.

44. Relation of the itinerary followed. Discussion of the work of inventory: Methods used, percentage of the territory covered, location of the sample plots, of control areas, growth studies, etc.

45. Suggestions re management, with discussions on the previous tending of the forest, explaining deficiencies of past systems on the lumbering methods used, and outlining the project of management based upon yield tables, with arguments in favor of same.

46. Chronological table of the various operations to be made each year for the lumbering, tending and improvement of the forest.

47. Suggestions on the subject of fire protection, lumbering, roads, streams improvements, reforestation, etc.

OFFICE OF THE CHIEF FOREST SERVICE.

Quebec, January 15, 1923.

(Advertisement of Timber Sale in Ontario.)

TENDERS

for

PULPWOOD AND TIMBER LIMIT

Tenders will be received by the undersigned up to and including the 22nd day of June, 1923, for the right to cut pulpwood and timber on a certain area situated in the watershed of the Trout and Chapleau Rivers in the District of Sudbury, comprising an area of 1,049 square miles.

Tenderers shall state the amount per cord on pulpwood that they are prepared to pay as a bonus in addition to dues of 80 cents per cord for spruce and 40 cents per cord for other pulpwoods, or such other rates as may from time to time be fixed by the Lieutenant-Governor in Council, for the right to operate a kraft pulp mill and a paper mill.

Tenderers shall also be required to say what they are prepared to pay, per thousand feet board measure, for the following classes of timber, over and above the upset prices in addition to Crown dues:

Red and white pine, upset price....................	**$6.00 per M. ft B. M.**
Spruce (too large for pulpwood), upset price..	**5.00 per M ft. B. M.**
Jack pine (banksian), upset price....	**2.50 per M ft B. M.**

The Crown dues on pine, including jackpine, being $2.50 and on spruce $2 per M. ft. b. m., or such other rates as may from time to time be fixed by the Lieutenant-Governor in Council.

The successful tenderer shall be required to erect a mill or mills within the limit or at some point in Ontario approved by the Minister, and to manufacture the wood into Kraft pulp, and also such portion thereof into Kraft paper when required so to do.

Parties making tender will be required to deposit with their tender a marked cheque, payable to the Honorable the Treasurer of the Province of Ontario, for fifty thousand dollars ($50,000) which amount will be forfeited in the event of the successful tenderer not entering into agreement to carry out conditions, etc.

The said $50,000 shall remain on deposit until the Kraft pulp mill, as provided by terms and conditions of sale, is erected and in operation. Any timber cut in the meantime shall be subject to payment of dues and bonus as accounts for same are rendered. After the said pulp mill is erected and in operation the deposit of $50,000 may be applied on account of bonus dues as they accrue, but the regulation dues as mentioned above shall be paid in the usual manner as returns for cutting of wood and timber are received and accounts rendered.

The highest or any tender not necessarily accepted.

For particulars as to description of territory, capital to be invested, etc., apply to the undersigned.

All tenders should be enclosed in sealed envelopes and marked plainly on outside "Tender for Trout-Chapleau Pulp and Timber Limit."

BENIAH BOWMAN,
Minister of Lands and Forests.

Toronto, April 16, 1923.

N. B.—No unauthorized publication of this notice will be paid for.

TIMBER SALE CONTRACT X........

PROVINCE OF BRITISH COLUMBIA
FOREST BRANCH
DEPARTMENT OF LANDS

Forest District................

THIS INDENTURE, made the day of , A.D. 192 , between His Majesty the King, represented and acting by , Minister of Lands for the Province of British Columbia (who, with his successors in office, is hereinafter "the Lessor"), of the one part, and Pacific Mills, Limited, whose registered office is situated at (hereinafter called "the Lessee"), of the other part.

WHEREAS by divers agreements entered into between the parties hereto certain tracts of timber had been and were in future to be demised to the Lessee for a period of thirty years from the 29th day of January, 1914, irrespective of the date of application for the same, upon payment of certain moneys which were fixed and agreed:

AND WHEREAS it was agreed that as and where the Lessee selected and made application for the demise of any timber comprised in the hereinbefore-mentioned agreements a formal contract should be executed for the purpose of carrying out the intention of the said agreements in respect of such selected timber:

AND WHEREAS the parties hereto have agreed that the timber hereinafter mentioned is comprised in and subject to the terms contained in the said agreements, and for the purpose of completely performing the said agreements in respect of the said selected timber have agreed to enter into the covenants, conditions, provisions, and agreements hereinafter contained:

NOW, THIS INDENTURE WITNESSETH that, in pursuance of the said agreement and in consideration of the payments and stipulations to be made and observed by and on the part of the Lessee, the Lessor doth hereby demise unto the Lessee, for the term and subject to the reservations and conditions hereinafter provided, a license to cut and remove all the merchantable timber upon an area which is agreed to comprise acres, situated and described as follows, and shown upon the map annexed and thereon colored red:

In consideration whereof the Lessee hereby covenants, promises, and agrees with the Lessor as follows: The Lessee shall pay to the Lessor the several sums at the times and in the manner following, namely:

(1) The sum of $, being years' rental at $ per annum, based on acres, at the rate of cents per acre for the period from the 29th day of January, 1914, to the date hereof (the receipt whereof is hereby acknowledged).

(2) An annual rental based as aforesaid amounting to $ annually in advance on the day of January in each

and every year during the continuance of the licence hereby granted; provided that such annual rental is to be reduced in each year by the omission from its computation of six hundred and forty acres or any multiple thereof when the said six hundred and forty acres or multiple thereof has been logged in the preceding year as proved to the satisfaction of the Lessor.

(3) For any saw timber cut or removed a sum per thousand feet equivalent to the rental which would have been payable under a special timber licence issued at the same date as the pulp licence (15,000 feet board measure being taken as the equivalent of one acre in computing the rental charge) in addition to the usual royalty.

(4) All forest-protection dues as provided in the "Forest Act" and amendments, payable annually in advance on the 29th day of January in each year during the life of this contract, and such dues to be payable from the 29th day of January, 1914, the receipt of the first annual payments whereof is hereby acknowledged.

(5) Royalties and the cost of scaling, payable as follows:

(6) The cost of cruising incident to this contract, being the sum of $.

(7) A stumpage price as follows: per thousand feet board measure in respect of all species cut since the 29th day of January, 1914, and hereafter to be cut under the terms of this contract and such stumpage price to be paid immediately upon receipt of account.

And the Lessee further covenants, promises, and agrees to cut and remove said timber in strict accordance with the following conditions and with all regulations and provisions governing timber sales in the "Forest Act" and amendments:

(1) No timber will be removed from the sale area until it has been conspicuously marked with the following registered mark issued for this timber sale: " ."

(2) Stumps will be cut so as to cause the least practicable waste, and will not be cut higher than inches, except in unusual cases in the discretion of the officer of the Forest Branch in charge.

(3) The following trees will be cut:

(4) No timber will be manufactured or sold until it has been properly scaled, as provided in the "Forest Act" and amendments, and in accordance with the following special provisions:

(5) All trees will be utilized to as low a diameter in the tops as practicable, so as to cause the least waste, and to the minimum diameter of inches when merchantable in the judgment of the officer of the Forest Branch in charge.

(6) Merchantable trees designated in clause 3 which are left uncut, timber wasted in tops and stumps, trees left lodged in the process of felling, and any merchantable timber which is cut and not removed from any portion of the cutting area after logging on that

portion of the cutting area is completed shall be scaled, measured, or counted as hereinbefore provided, and paid for as follows:

(7) Brush will be disposed of as follows:

(8) Provided that, the Lessee not being in default hereunder, the licence hereby granted is to be renewable yearly upon the payment of the annual rentals and forest-protection dues at the times and in the manner hereinbefore specified, for the term of thirty (30) years from January 29th, 1914, on which said date all rights of the Lessee hereunder shall absolutely terminate and any and all timber then cut from and lying on the said lands shall be and become the absolute property of the Lessor.

(9) Provisions for fire protection:

The Lessee agrees that the sum of $, which accompanied tender for timber covered by this contract, shall be held until the completion of the contract; and provided that the contract has been faithfully carried out to the satisfaction of the Lessor will be refunded; otherwise this amount will be subject to such deductions as the Lessor may find necessary in order to carry out the full intent and provisions of this contract; or otherwise will be forfeited.

Except as may otherwise be provided by any Statute or Order in Council that may from time to time be in force, all timber cut under this contract shall be used in this Province, or be manufactured in this Province into boards, lath, shingles, or other sawn lumber, to such an extent to be of use in the trades without further manufacturing, except in the case of piles, telegraph and telephone poles, ties, and crib timber, which may be exported under an Order in Council.

The Lessee covenants with the Lessor that he will not sublet, assign, transfer, set over, or in any way change the licence hereby granted, or any part thereof or interest therein, without the written consent of the Lessor first had and obtained.

Provided that the Lessee in accepting this contract does so on the express understanding that no Chinese or Japanese shall be employed in connection therewith.

The decision of the Minister of Lands will be final in the interpretation of any of the terms and conditions of this contract.

The Forest Officer in charge, by giving notice to that effect in writing to the Lessee, or to the person in charge of logging operations upon the area, may suspend any logging operation conducted upon this area, should violation of any of the terms or conditions of this contract have occurred; and such violation shall render this contract liable to cancellation by the Minister of Lands.

Provided further that the interest, rights, and privileges of the Lessee in the said hereditaments, tenements, and premises shall be construed as subject always to all the provisions of the "Forest Act" and amendments thereof.

In witness whereof the parties hereto have hereunto set their hands and seals the day and year first above written.

Signed, sealed, and delivered on behalf of the within-named Lessor in the presence of— [SEAL.]

Signed, sealed, and delivered on behalf of the within-named Lessee in the presence of— [SEAL.]

(*Lessee or Purchaser.*)

(Designation)

TIMBER SALE AGREEMENT

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Description of Timber.—1. ...., ...
(I or we) (If copartnership, "We, and
....
partners, doing business under the firm name and style of ")
....
(If corporation, "A corporation organized and existing under the laws of the State (or
....
Territory) of , having an office and principal place of business at ")
of........................., State of.........................., hereby agree to purchase from an area of about......................acres to be definitely designated on the ground by a Forest officer prior to cutting, in
....
(Give approximate location and describe by relation to some well-known landmark,
....
stream, etc. Give also legal subdivisions if surveyed, and approximate legal subdivision
....
if unsurveyed.)
within the................National Forest, at the rate or rates, and in strict conformity with all and singular the requirements and conditions hereinafter set forth, all the dead timber standing or down and all the live timber marked or designated for cutting by a Forest officer, merchantable as hereinafter defined, for..
(Name products to be cut, sawlogs, ties, etc.)
....
The estimated amount to be cut under the methods of marking described in section 5 is...
....
(Give by species the quantity in proper unit of measure, state whether live or dead, and
...., more or less.
kind of material.)

Payments.—2. .... do hereby, in consideration of the sale of this
(I or we.)
timber to............promise to pay to the............................
(Me or us.)
National Bank of........................(United States depository), or such other depository or officer as shall hereafter be designated, to be

placed to the credit of the United States, for the timber at the following rates:

....

(Per thousand feet b.m., cords, linear feet, etc.)

....

Payments shall be made in advance installments of not less than ....dollars ($..............) and not more than dollars............................ ($..............) each when called for by the Forest officer in charge, except just before the completion of the sale or a period when cutting operations are to be suspended for at least ....months, when the amount of the payment shall be designated in writing by the Forest Supervisor, credit being given for the sums, if any, heretofore deposited with the said United States depository or officer in connection with this sale.

Period of Contract.—3. Unless extension of time is granted, all timber shall be cut and removed and the requirements of this agreement satisfied on or before.................................... Unless such amounts are
(Date.)
reduced in writing by the .... at least ....
(Title of approving officer.) (Feet b. m., cords, etc.)
shall be cut prior to ....; at least ....
(Date.) (Feet b. m., cords, etc.)
shall be cut prior to ....; at least ....
(Date.) (Feet b. m., cords, etc.)
shall be cut prior to ....
(Date.)

Title.—4. The title to all timber included in this agreement shall remain in the United States until it has been paid for, and scaled, measured, or counted, as herein provided.

Timber upon valid claims and all timber to which there exists valid claim under contract with the Forest Service is exempted from this sale.

Marking.—5. Live timber shall be marked for cutting as follows:......

....

(Insert suitable provision so that the system of cutting and method of designation will be

....

clear.)

....

....

Any tree which in the judgment of the Forest officer contains one or more logs merchantable as hereinafter defined, and having a net total scale of .... per cent or more of the total volume of the tree, shall be considered merchantable under the terms of this agreement and may be marked or designated for cutting by the Forest officer.

Logging.—6. As far as may be deemed necessary for the protection of National Forest interests, the plan of logging operations on the respective portions of the sale area shall be approved by the Forest officer in charge. When operations are begun on any natural logging area, the cutting on that area shall be fully completed to the satisfaction of the Forest officer in charge before cutting may begin on other areas, unless such cutting is authorized in writing with the requirement that cutting shall be completed on the area left unfinished as soon as practicable. After decision in writing by the Forest officer in charge that the purchaser has complied satisfactorily with the contract requirements as to specified areas, the purchaser shall not be required to do additional work on such areas.

7. Any method of logging other than by means of........ ....

....
(Indicate whether by horses, donkey engines, etc.)

may be employed only with the advance approval in writing of the Forest officer approving this agreement and under such conditions and restrictions as he may require.

8. All and only marked or designated live trees shall be cut. No timber shall be cut until paid for, nor removed from the place or places agreed upon for scaling until scaled, measured, or counted by a Forest officer.

9. No unnecessary damage shall be done to young growth or to trees left standing, and no trees will be left lodged in the process of felling. Unmarked or undesignated trees which are badly damaged in logging shall be cut if required by the Forest officer in charge.

10. Unmarked or undesignated live trees which are cut, or injured through carelessness, and marked or designated trees left uncut, shall be paid for at double the current price for the class of material which they contain fixed in accordance with the terms of this agreement.

Timber wasted in tops or stumps, marked or designated timber broken by careless felling, and any timber merchantable, according to the terms of this agreement, which is cut and not removed from any portion of the cutting area when operations on such portion are completed, or before this agreement expires or is otherwise terminated, shall be paid for at the current price for such material.

The amounts herein specified shall be regarded as liquidated damages and may be waived in the discretion of the Forest officer in charge in accidental or exceptional cases which involve small amounts of material Any timber remaining on the sale area at the expiration or termination of this agreement, for which payment as herein specified has been made to the United States, may be removed within ...... months from such date of expiration.

11. All cutting shall be done with a saw when practicable; stumps shall be cut so as to cause the least practicable waste, and not higher than .... inches on the side adjacent to the highest ground, except in unusual cases when, in the discretion of the Forest officer in charge, this height is not considered practicable; all trees shall be utilized to as low a diameter in the tops as practicable and to a minimum diameter of when .... inches ....
(Specify different diameters for different species, if necessary.)

merchantable in the judgment of the Forest officer in charge. The log lengths shall be varied so as to secure the greatest possible utilization of merchantable material.

Scaling and Merchantability.—12. Material shall be piled or skidded for scaling, measurement, or count if required by the Forest officer in charge and in such manner as he shall direct.

Sawlogs shall be scaled by the Scribner Decimal C log rule, at the small end on the average diameter inside bark taken to the nearest inch.

....
(Insert methods of counting or measuring other products.)

....

....

....

....

13. The maximum scaling length of sawlogs shall be ...... feet; greater lengths will be scaled as two or more logs. Upon all logs ...... inches shall be allowed for trimming. Logs overrunning the specified trimming allowance shall be scaled not to exceed the next foot in length.

14. All .... logs are merchantable under the
(Species.)
terms of this agreement which are not less than ...... feet long, at least ...... inches in diameter inside bark at the small end, and after deductions for visible indications of defect scale ...... per cent of their gross scale; and logs of other species not less than ...... feet long, ... inches in diameter inside bark at small end, and scaling ...... per cent of their gross scale; provided that ....
(Name defects for which deductions will not be made in scaling.)
shall not be regarded as defects.

Material unmerchantable on account of defects may be removed without charge in the discretion of the District Forester.

Brush Disposal.—15. Slash shall be disposed as follows: ....

....

....

....

....

....

16. As far as practicable all branches of logging shall keep pace with one another, and in no instance shall brush disposal be allowed to fall behind cutting, except when the depth of snow or other adequate reason makes proper disposal impracticable, when the disposal of brush may, with the written consent of the Forest officer in charge, be postponed until conditions are more favorable.

Fire Protection.—17. During the time that this agreement remains in force the purchaser shall independently do all in his power to prevent and suppress forest fires on the sale area and in its vicinity, and shall require his employees, contractors, and employees of contractors to do likewise. Unless prevented by circumstances over which he has no control, the purchaser shall place his employees, contractors, and employees of contractors at the disposal of any authorized Forest officer for the purpose of fighting forest fires, with the understanding that unless the fire-fighting services are rendered on the area embraced in this agreement or on adjacent areas

....
(Describe by topographic features or legal subdivisions.)

....

....

payment for such services shall be made at rates to be determined by the

Forest officer in charge, which rates shall not be less than the current rates of pay prevailing in the said National Forest for services of a similar character: *Provided,* That the maximum expenditure for fire fighting without remuneration in any one calendar year, at rates of pay determined as above, shall not exceed $.........; and further provided, that if the purchaser, his employees, contractors, or employees of contractors are directly or indirectly responsible for the origin of the fire, no payment shall be made for services so rendered, nor shall the cost of such services be included in determining said maximum expenditure for any calendar year.

It is further agreed that except in serious emergencies as determined by the Forest Supervisor the purchaser shall not be required to furnish more than .... men for fighting fires outside of the area above specified, and that any employees furnished shall be relieved from fire fighting on such outside areas as soon as it is practicable for the Forest Supervisor to obtain other labor adequate for the protection of the National Forest.

Occupancy and Improvements.—18. The purchaser is authorized to build, on National Forest land, sawmills, camps, railroads, roads, and other improvements necessary in the logging or the manufacturing of the timber included in this agreement: *Provided,* That all such structures and improvements shall be located and operated subject to such regulation by the Forest officer in charge as may be necessary for the protection of National Forest interests. The continuance or operation of such improvements on National Forest land after this agreement has terminated shall be subject to authorization by permit or easement under United States laws, and unless such authorization is secured all improvements not removed shall become the property of the United States at the expiration of six months from the termination of this agreement.

19. All merchantable .... timber used in the construction of buildings, roads, and other structures, necessary in connection with the cutting and removal of the timber covered by this agreement, shall be paid for at the current rates for such material under this agreement. Merchantable material of other species, cull material, and unmerchantable tops of any species may be used for such purposes without charge and shall be left in place where used.

20. Logging camps, mills, stables, and other structures, and the ground in their vicinity, shall be kept in a clean, sanitary condition, and rubbish shall be removed and burned or buried. When camps or other establishments are moved from one location to another or abandoned, all débris shall be burned or otherwise disposed of as the Forest officer in charge shall direct.

21. All telephone lines and fences crossing the sale area shall be protected as far as possible in logging operations and if injured shall be repaired immediately by the purchaser; all roads and trails traversing the sale area, whose maintenance or repair is considered necessary by the Forest officer in charge, shall be repaired or reconstructed if injured, and kept free from obstruction by logs, brush, or débris by the purchaser, as the Forest officer shall require.

Sawlogs shall be scaled by the Scribner Decimal C log rule, at the small end on the average diameter inside bark taken to the nearest inch.

....
(Insert methods of counting or measuring other products.)

....

....

....

....

13. The maximum scaling length of sawlogs shall be ...... feet; greater lengths will be scaled as two or more logs. Upon all logs ...... inches shall be allowed for trimming. Logs overrunning the specified trimming allowance shall be scaled not to exceed the next foot in length.

14. All .... (Species.) logs are merchantable under the terms of this agreement which are not less than ...... feet long, at least ...... inches in diameter inside bark at the small end, and after deductions for visible indications of defect scale ...... per cent of their gross scale; and logs of other species not less than ...... feet long, ... inches in diameter inside bark at small end, and scaling ...... per cent of their gross scale; provided that .... (Name defects for which deductions will not be made in scaling.) shall not be regarded as defects.

Material unmerchantable on account of defects may be removed without charge in the discretion of the District Forester.

Brush Disposal.—15. Slash shall be disposed as follows: ....

....

....

....

....

....

16. As far as practicable all branches of logging shall keep pace with one another, and in no instance shall brush disposal be allowed to fall behind cutting, except when the depth of snow or other adequate reason makes proper disposal impracticable, when the disposal of brush may, with the written consent of the Forest officer in charge, be postponed until conditions are more favorable.

Fire Protection.—17. During the time that this agreement remains in force the purchaser shall independently do all in his power to prevent and suppress forest fires on the sale area and in its vicinity, and shall require his employees, contractors, and employees of contractors to do likewise. Unless prevented by circumstances over which he has no control, the purchaser shall place his employees, contractors, and employees of contractors at the disposal of any authorized Forest officer for the purpose of fighting forest fires, with the understanding that unless the fire-fighting services are rendered on the area embraced in this agreement or on adjacent areas

....
(Describe by topographic features or legal subdivisions.)

....

....

payment for such services shall be made at rates to be determined by the and none of its terms can be varied or modified except in writing by the Forest officer approving the agreement or his successor or superior officer, and in accordance with the regulations of the Secretary of Agriculture. No other Forest officer has been or will be given authority for this purpose.

And as a further guarantee of a faithful performance of the conditions of this agreement .... deliver herewith a bond in the sum of
(I or we.)
.... ($........), and do further agree that all moneys paid under this agreement shall, upon failure on ....
(My or our.)
part to fulfill all and singular the conditions and requirements herein set forth, or made a part hereof, be retained by the United States to be applied as far as may be to the satisfaction of .... obligations
(My or our.)
assumed hereunder. .... do further agree that should the sureties
(I or we.)
on the bond delivered herewith or on any bond delivered hereafter in connection with this sale become unsatisfactory to the officer approving this agreement, ... will within thirty days of receipt of demand
(I or we.)
furnish a new bond with sureties solvent and satisfactory to the approving officer.

Signed in duplicate this .... day of ...., 191
(Same date as bond.)
(Corporate seal, if corporation.)

*Witnesses:

....
(Signature of purchaser.) (See note.)

....
(Signature of purchaser.)

....
(Title.)

Approved at ...., under the above conditions,
................................., 191

....
(Signature of approving officer.)

....
(Title.)

---

* Signature of two witnesses required if sale is over $100.

If contracting party is a copartnership, form of signature should be

X Y Z Company,
By John Doe,
A Member of Firm.

If contracting party is a corporation, form of signature should be

X Y Z Company,
By John Doe,
President (or other officer or agent),

and the seal of the corporation must be impressed as indicated.

COST TABLES

To facilitate calculations of the cost of growing timber, the following tables, which show the charges for land and stocking, taxes and protection by decades from 30 to 100 years, at various rates, are reproduced from "The Cost of Growing Timber," written by R. S. Kellogg and E. A. Zeigler in 1909:

LAND AND STOCKING

	Original cost, $5 per acre				Original cost, $10 per acre			
Years	Amount at 3 per cent	Amount at 4 per cent	Amount at 5 per cent	Amount at 6 per cent	Amount at 3 per cent	Amount at 4 per cent	Amount at 5 per cent	Amount at 6 per cent
30.. .	$12.14	$ 16 22	$ 21 61	$ 28.72	$ 24 27	$ 32 43	$ 43 22	$ 57.44
40.. .	16.31	24 01	35 20	51 43	32 62	48 01	70.40	102.86
50.. .	21 92	35 53	57 34	92 10	43 84	71.07	114 67	184.20
60.. .	29 46	52 60	93 40	164 94	58 92	105 20	186.79	329 88
70.. .	39 59	77 86	152 13	295.39	79 18	155 72	304.26	590 77
80....	53 20	115 25	247 81	528.99	106 41	230 50	495.61	1,057 99
90....	71.50	170 60	403 65	947 35	143 01	341 19	807.30	1,894.70
100...	96 09	252 52	657.51	1,606 56	192.19	505.05	1,315.01	3,393.13

	Original cost, $15 per acre				Original cost, $20 per acre			
Years	Amount at 3 per cent	Amount at 4 per cent	Amount at 5 per cent	Amount at 6 per cent	Amount at 3 per cent	Amount at 4 per cent	Amount at 5 per cent	Amount at 6 per cent
30....	$ 36.41	$ 48 65	$ 64 83	$ 86 15	$ 48.55	$ 64 87	$ 86.44	$ 114 87
40.. .	48 93	72.02	105 60	154.29	65 24	96.02	140.80	205.71
50....	65 76	106 60	172 01	276 30	87 68	142.13	229.35	368 40
60.. .	88 37	157 79	280 19	494.82	117.83	210 39	373.58	659.77
70.. .	118.77	233 57	456.40	886 16	158 36	311 43	608 53	1,181.54
80....	159.61	345 75	743 42	1,586 98	212 82	461.00	991 23	2,115 97
90.. .	214.51	511 79	1,210.96	2,842 05	286 01	682 39	1,614.61	3,789.40
100...	288 28	757.57	1,972 52	5,089.69	384 37	1,010 10	2,630.02	6,786.25

TAXES*

Years	Amount at 3 per cent Yearly cost per acre, 10 cents	Yearly cost per acre, 15 cents	Yearly cost per acre, 20 cents	Yearly cost per acre, 25 cents	Amount at 4 per cent Yearly cost per acre, 10 cents	Yearly cost per acre, 15 cents	Yearly cost per acre, 20 cents,	Yearly cost per acre, 25 cents
30..	$ 4.76	$ 7 14	$ 9 52	$ 11 80	$ 5 61	$ 8 41	$ 11 22	$ 14 02
40..	7 54	11 31	15 08	18 85	9 50	14 25	10 01	23 76
50..	11 28	16 92	22 56	28 20	15 27	22 90	30 53	38 17
60..	16 31	24 46	32 61	40 76	23 80	35 70	47 60	59 50
70...	23 06	34 59	46 12	57 65	36 43	54 64	72 86	91 07
80..	32 14	48 20	64 27	80 31	55 12	82 69	110 25	137 81
90 .	44 33	66 50	88 67	110 84	82 80	124 20	165 60	207 00
100..	60 73	91 00	121 16	151 82	123 76	185 64	247 52	300.41

---

* If it is desired to compute the taxes at some rate not given above, the amount may be obtained by using either the figures given in the table for protection or by combining them with those in this table. For example, the total tax at a rate of 19 cents for 60 years at 3 per cent is equivalent to the total tax at 4 cents ($0 52 in the protection table) plus the total tax at 15 cents ($24.46 in the tax table), or $30.98.

Years	Amount at 5 per cent Yearly cost per acre, 10 cents	Yearly cost per acre, 15 cents	Yearly cost per acre, 20 cents	Yearly cost per acre, 25 cents	Amount at 6 per cent Yearly cost per acre, 10 cents	Yearly cost per acre, 15 cents	Yearly cost per acre, 20 cents	Yearly cost per acre, 25 cents
30....	$ 6.64	$ 9.97	$ 13 29	$ 16 61	$ 7 91	$ 11 86	$ 15 81	$ 19 76
40....	12.08	18 12	24 16	30 20	15 48	23 21	30.95	38.69
50....	20 93	31 40	41 87	52 34	29 03	43 55	58 07	72 58
60....	35.36	53 04	70 72	88 40	53 31	79 97	106 63	133 28
70....	58.85	88 28	117 71	147 13	96 80	145 19	193 59	241 99
80...	97 12	145.68	194 25	242 81	174 66	262 00	349 33	436 66
90.. .	159.46	239 19	318 92	398 65	314.12	471 17	628 23	785.29
100...	261.00	391 50	522 01	652 51	563 85	845 78	1,127 71	1,409.64

Administration and Protection

	Amount at 3 per cent						Amount at 4 per cent					
Yrs.	Yearly cost per acre, 1 cent	Yearly cost per acre, 2 cents	Yearly cost per acre, 3 cents	Yearly cost per acre, 4 cents	Yearly cost per acre, 5 cents	Yearly cost per acre, 6 cents	Yearly cost per acre, 1 cent	Yearly cost per acre, 2 cents	Yearly cost per acre, 3 cents	Yearly cost per acre, 4 cents	Yearly cost per acre, 5 cents	Yearly cost per acre, 6 cents
30	$0.48	$0 95	$1.43	$1.90	$2.38	$2 85	$0.56	$1.12	$1.68	$2.24	$2.80	$3 37
40	0.75	1 51	2 26	3 02	3 77	4.52	0.95	1.90	2 85	3.80	4.75	5.70
50	1 13	2.26	3 38	4 51	5.64	6.77	1.53	3 05	4 58	6.11	7.63	9 16
60	1.63	3 26	4.89	6 52	8 15	9.78	2 38	4 76	7 14	9 52	11.90	14.28
70	2.31	4.61	6.92	9 22	11 53	13.84	3.64	7.29	10 93	14 57	18.21	21.86
80	3.21	6.43	9 64	12 85	16.07	19.28	5 51	11.02	16 54	22.05	27 56	33.07
90	4.43	8.87	13.30	17.73	22.17	26 60	8 28	16.56	24 84	33.12	41.40	49.68
100	6.07	12.15	18.22	24 29	30 36	36 44	12.38	24.75	37.13	49.50	61.88	74 26

	Amount at 5 per cent						Amount at 6 per cent					
Yrs.	Yearly cost per acre, 1 cent	Yearly cost per acre, 2 cents	Yearly cost per acre, 3 cents	Yearly cost per acre, 4 cents	Yearly cost per acre, 5 cents	Yearly cost per acre, 6 cents	Yearly cost per acre, 1 cent	Yearly cost per acre, 2 cents	Yearly cost per acre, 3 cents	Yearly cost per acre, 4 cents	Yearly cost per acre, 5 cents	Yearly cost per acre, 6 cents
30	$0.66	$1.33	$1.99	$2 66	$3 32	$3 99	$0.79	$1.58	$2.37	$3.16	$3.95	$4.74
40	1.21	2.42	3.62	4.83	6 04	7 25	1.55	3.10	4 64	6 19	7.74	9.29
50	2.09	4.19	6 28	8.37	10.47	12.56	2 90	5.81	8.71	11.61	14.52	17.42
60	3.54	7.07	10.61	14.14	17.68	21.22	5.33	10 66	15.99	21.33	26.66	31.99
70	5 89	11.77	17.66	23.54	29.43	35 31	9 68	19.36	29 04	38.72	48.40	58.08
80	9.71	19.42	29.14	38 85	48.56	58.27	17.47	34 93	52 40	69.87	87.33	104.80
90	15.95	31.89	47.84	63.78	79.73	95.68	31.41	62 82	94.23	125.65	157.06	188.47
100	26.10	52.20	78.30	104 40	130.50	156.60	56 39	112.77	169.16	225.54	281.93	338.31

PULPING PROPERTIES OF SOME WOODS

Some of the data upon the properties and pulp yields of the principal American woods, given in detail on page 99, are here summarized for ready reference. It must be borne in mind, however, that the relative values of the various woods cannot be determined from these figures alone. Strength, color and bleaching properties may be more important than anything here shown.

Species	Fiber length	Wt. per cu. ft.	Yield per 100 cu. ft.			
			Mech.	Sulphite	Soda	Sulphate
	(*mm.*)	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
Alder, red	1.2	28			1,160	..
Ash, white	1.2	34		1,530	1,350	
Aspen	1.0	23	2,170	1,030	1,080	
Aspen, largetooth	1.1	22	2,170	1,000	1,000	.
Basswood	1.1	21			1,020	
Beech	1.1	36			1,530	
Birch, paper	1.2	34	3,000	1,500	1,350	.
yellow	1.5	34		1,590	1,360	
Boxelder		30		.	1,300	.
Buckeye		21		940	940	....
Butternut	1.2	22		1,000	1,000	..
Catalpa	.	31		1,390	1,340	......
Cedar, incense	2.0	23		920	..	950
Port Orford	3.6	26		1,150	.	960
red	2.8	27		1,300		1,000
Southern white	2.1	20		1,000		780
Western red	3.8	19	.	830	.	830
Cottonwood	1.3	23	2,180	1,035	1,030	.
Cucumber	1.3	27	.	1,250	1,200	.....
Cypress	3.3	27		1,160	...	1,350
Douglas fir	4.4	28	.	1,200	..	1,178
Elm, cork	1.3	36		1,620	1,620	...
slippery	1.7	30		....	1,260	.
white	1.6	27	.	...	1,080	.....
Fir, alpine	...	21	2,070	1,010	.	1,050
balsam	2.7	21	1,910	970		1,010
grand	3.2	23	1,950	980	.	1,140
noble	......	22	1,920	1,010	..	1,080
red	....	23	1,915	1,080	..	1,150
silver	......	22	1,870	1,060	....	1,100
white	3.5	22	2,010	950	.....	1,100

Species	Fiber length	Wt. per cu. ft.	Yield per 100 cu. ft.			
			Mech.	Sulphite	Soda	Sulphate
	(mm.)	lb.	lb.	lb.	lb.	lb.
Gum, black	1.7	30	2,610	......	1,300	......
red	1.6	27	......	1,190	1,080	......
tupelo	1.6	29	......	1,160	1,200	......
Hackberry	1.1	30	......	1,300	1,200	......
Hemlock, Carolina	......	30	......	1,290	......	1,260
Eastern	3.0	24	2,030	1,080	......	......
Western	2.7	23	2,160	1,050	......	1,100
Hickory, mockernut	1.4	40	......	1,680	1,380	......
Larch, Western	2.6	28	2,100	1,200	......	1,290
Locust	......	41	......	1,970	1,700	......
Magnolia, sweet	1.3	39	......	1,680	1,680	......
Oak, red	1.5	35	......	1,600	1,400	......
white	1.5	37	......	1,600	1,480	......
Maple, red	0.8	30	......	1,450	1,300	......
sugar	......	35	......	1,540	1,500	......
Palmetto, cabbage	......	23	......	1,400	1,150	......
Pine, cuban	......	37	......	......	......	1,650
jack	2.5	24	2,130	1,080	......	1,150
limber	......	23	......	1,000	......	1,040
loblolly	3.0	30	2,450	1,140		1,420
lodgepole	2.3	24	2,140	1,080		1,120
longleaf	3.7	34	......	1,840		1,600
Norway	3.7	27	......	1,230		1,350
pinon	2.0	31	......	1,330		1,300
pitch	......	29	......	1,250		1,430
pond	......	31		1,360	......	1,400
sand	......	29	......	1,300	......	1,220
Scotch	......	37	......	1,600	......	1,600
Pine, scrub	2.8	26		1,600	......	1,250
shortleaf	3.7	31	......	1,500	......	1,450
sugar	4.1	23	......	1,010	......	1,150
Western yellow	3.6	24	2,060	1,130	......	1,100
white	3.8	22	1,890	1,210	......	1,100
Poplar, balsam	1.0	26	......	1,300	1,190	......
Redwood	5.5	23	......	1,100	......	950
Sassafras	0.9	26	......	......	780	......

Species	Fiber length	Wt. per cu. ft.	Yield per 100 cu. ft.			
			Mech.	Sulphite	Soda	Sulphate
	(*mm.*)	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
Spruce black	2 6	23		1,050	...	1,150
blue	2 8	23		1,050	....	1,150
Englemann	3 0	21	2,100	990	....	1,000
Norway	.....	30	..	1,350		....
red	3 7	24	2,400	1,080	.	1,150
Sitka	3 5	24	2,040	1,080	..	1,150
white	2 8	24	2,400	1,030	....	.....
Sycamore	1 7	29	......	1,300	1,300	......
Tamarack	2 6	31	2,620	1,270	......	1,400
Tuliptree	1 8	26	....	1,170	1,150	....
Willow, black	0 8	21	.	1,100	950	....
longleaf	0 7	23	....	1,100	1,030	....
Yucca	....	18			720	....

INDEX

A

Alder, red, properties of, 99
Annual timber cut, decrease, 174
Ash, white, properties of, 99
Aspen, largetooth, properties of, 100
Aspen, properties of, 100

B

Balsam fir, 9, 21, 23, 87, 89, 91, 110, 193
Bark beetle, 192
Basswood, properties of, 101
Birch, properties of, 102
Birch, paper, properties of, 102
  yellow, properties of, 102
Blight, chestnut, 191
Box elder, properties of, 103
British Columbia, forest resources of, 160–164
Buckeye, properties of, 103
Budworm, 157–159, 189, 192, 193
Butternut, properties of, 104

C

Canada, consumption of pulpwood, 92, 94
  estimated timber supply, 152, 154
  exports of pulp, 45, 47
  land surface, 153
  merchantable timber, 154
  paper mills, magnitude of, 13
  policies recommended, 214
  prairie provinces, 160
  public ownership, 170
  pulpwood production, 69, 71, 73, 74
  soda pulp, 37
  total pulpwood resources of, 155
  total pulpwood used, 9
Canada, water power, 22
  woodpulp in, 40
Cape Breton Island, 159
Catalpa, properties of, 104
Cedar, incense, properties of, 104
  Port Orford, properties of, 105
    properties of, 105
  Southern white, properties of, 106
  Western red, properties of, 106
Chestnut, disappearance of, 191
Conversion factors, 62
Cord, French, 61
  measurement, 60
  shrinkage, 61
Cost tables, timber growing, 262
Cottonwood, properties of, 106
Crocker, Alvah, 19
Cucumber, properties of, 107
Cypress, properties of, 107

D

Douglas fir, 151, 162
  properties of, 108
Doyle rule, 59

E

Elm, cork, properties of, 108
  slippery, properties of, 108
  white, properties of, 109

F

Fir, alpine, properties of, 109
  balsam, properties of, 110
  grand, properties of, 110
  Noble, properties of, 110
  red, properties of, 111
  silver, properties of, 111
  white, properties of, 112
Fire protection, cost, 195

Forest and woodland, in United States, 138
  British Columbia Coast, 162
  central hardwood, 141
  conservation committee, recommendations, 211–214
  fires, 177, 191, 208
    damage, 143, 144, 145
    prevention, 207
  National, development of, 168
  Northern, 140
  ownership, Federal distribution, 167
    in Canada, 170
  Pacific, 145
  Products Laboratory, pulpwood tests, 97
  regions, 137–146
  Rocky Mountain, 143
  Southern, 140
  survey and working plans, Quebec, 247–250
Forestry, Canadian policies, 214
  chance for, 177
  cost of, 194
  Federal policies, 209
  hazards of, 191
  methods of, 184
  National economy, problem, 202
  need for, 173
  Quebec government order, 187
  State policies, 211
  where it should begin, 179
  working plans, 185
Forests, depletion of, 137
  inventory of needed, 207
  National, 142

G

Groundwood, 17
  cords consumed, 79, 80
  imports into United States, 228
  mills, capacity of, 19, 21
  uses of, 23, 25
Gum, black, properties of, 112
  red, properties of, 112
  Tupelo, properties of, 113

H

Hackberry, properties of, 113
Hardwoods, cost of, 92, 94
  present stand, 149
Hemlock, 87, 91, 152
  Carolina, properties of, 114
  Eastern, properties of, 114
  Western, 162
    properties of, 114
Hickory, mockernut, properties of, 115

I

Interest rates, 197

J

Japan, exports to, 49

K

Kraft (see *Sulphate pulp*), 39

L

Labrador, 159
Lake States, annual consumption, 182
  average production, 182
  estimated stand, 182
  importations from Canada, 182
Land surface, classification of, in Canada, 153
  values, 195
Larch saw-fly, 191
  Western, properties of, 115
Locust, properties of, 116
Logging, 53
  British Columbia, 57
  Pacific coast, 57
  railroad, 55
  transportation of pulpwood, 55
  working capital, 57
Log scales, 58

M

Magnolia, sweet, properties of, 116
Maple, red, properties of, 116
  sugar, properties of, 117

Mechanical process (see *Groundwood*), 17
Mexico, timber, 164
Moisture, percentage of, 63
"Muskeg" growth, 164

N

National economy, 202
  forests, creation of,
    development of, 168
    timber sale form, 255–261
    policy, outline, 209–211
New Brunswick, forest resources, 158
New York State, forestry practice, 180, 181
  wood import, 181
New Zealand, definition of forestry, 175
Newfoundland, forest resources, 159
News print, first in Canada, 19
  composition of, 25
    in United States and Canada, 24
  mill cost of, 13
  production, 26
North America, total timber, 164
Nova Scotia, forest resources, 159

O

Oak, red, properties of, 117
  white, properties of, 118
Ontario, forest resources, 158

P

Pacific coast future development of, 146
  public ownership, 169
  pulpwood used, 83
Palmetto, cabbage, properties of, 118
Paper and pulp in North America, 6
  consumption of, 12, 14, 15
  first, 4
    in North America, 49
  magnitude of the American industry, 11
  papyrus, 4
Paper, quantity materials, 1919, 11
  rag, 4
  raw materials used in manufacture of, in United States, 223
Paper-making, application of power, 5
  growth of, 7
  processes, 16
    mechanical, 17
    soda, 34
    sulphate, 39
    sulphite, 27
Paper-mills, first United States, 5
Papyrus, 4
Pine, first used, 89
  beetles, 192
  Cuban, properties of, 118
  jack, properties of, 119
  limber, properties of, 120
  loblolly, properties of, 120
    properties of, 120
  longleaf, properties of, 121
  Norway, red, properties of, 122
  pinon, properties of, 122
  pitch, properties of, 123
  pond, properties of, 123
  sand, properties of, 123
  Scotch, properties of, 124
  scrub, properties of, 125
  shortleaf, properties of, 125
  sugar, properties of, 125
  Western yellow, properties of, 125
  white, decrease of stand, 181
    properties of, 126
Poplar, 87, 90, 91
  balsam, properties of, 126
Public Lands, distribution of, 167
  ownership, Canada, 170
    European countries, 184
    United States, 169
Pulp and paper, industry in Canada, 13, 234
  industry in United States, 10, 223
Pulp industry, rated capacity, 18
Pulping properties of woods, 266, 267
Pulpwood, average cost, 91–96
  Canadian exports of, 69, 74

Pulpwood, comparative consumption, 75
  costs of, in United States and Canada, 91, 94
  processes in Canada, 76–80
  quantities, Canada, 86, 87
  quantities used by regions in United States, 81–85
 consumption in Canada, by species, 92, 237
  in United States by species, 90, 232
 defects in, 65
 grades, 65
 measurement of, 60
 principal species used in Canada, 92
  in United States, 90
 properties of woods, summarized, 266, 267
  poplar, balsam, 126
 requirements, 9
 total resources of Canada, 155
 used by processes, chart of, 76, 78
 used in Canada, by provinces, 237
 used in Mexico, 164
 used in United States, by processes, 231
 used in United States and Canada, 67–91, 230, 233
 value of exports from Canada, 73, 238
Pulpwoods, forest service data, 97–133
 laboratory tests of, 97
 total consumption, United States and Canada, 9, 77

Q

Quebec, forest resources of, 156–158
 log rule, 60

R

Records, preservation of, 3
Redwood, properties of, 127

S

Sassafras, properties of, 127
Scaling device, automatic, 63
Soda process, 34–39
 cords consumed, 231, 235
 pulp, mills, cost of, 37
  location of, 37
 species used, 38
 uses of, 35
Softwoods, present stand of, in the United States, 150
 in Canada, 152
Species, used for pulp, 87–91, 232, 237
Spruce, 9, 88, 89, 91
 black, properties of, 128
 blue, properties of, 128
 Engelmann, properties of, 128
 Norway, properties of, 129
 Sitka, properties of, 129
 white, properties of, 130
State forest preserves, 168, 169
Sulphate process, 39
 cords consumed, 78–81, 231, 236
 imports into United States, 48, 230
 mills, cost of, 41
  location of, 41
 species used, 42
Sulphite mills, capacity of, 29
 process, 27
  cords consumed, 78, 79, 231, 236
 pulp, imports into United States, 46, 229
  market value, 33
  mills, cost of, 34
  producing countries, 31
  species used, 31
  uses of, 34
Sycamore, properties of, 130

T

Tamarack, properties of, 130
Taxes, timber, 195

- Timber, annual growth required, 178
  - cost to grow crop, 194
  - cut in New England, 180
    - in New York State, 181
  - destructive insects, 192
  - growing, cost tables, 262
  - hardwoods, present stand of, in the United States, 149
    - in Canada, 152
    - in Mexico, 164
    - North America, 164
  - land values, 195
  - present cut of, 173
    - stand, 173
    - stand of in Canada, 152
  - sale, Canadian contract, samples of, 251–255
    - United States agreements, samples of, 255–261
  - saw, present stand of,
    - in the United States, 148
    - in Canada, 152
  - shortage, 165
  - softwoods, present stand of, in the United States, 150
    - in Canada, 152
  - stand of merchantable size in Canada, 154
  - supply program, essentials in, 205
  - taxes, 195
  - virgin, in the United States, 177
- Timberland, public ownership, reasons for, 205
  - statutory, British Columbia, 161
- Tulip tree, yellow poplar, properties of, 131

U

- United States, imports of pulp, 46, 48, 228–230

W

- Water power, Canada, 22
- Willow, black, properties of, 131
  - longleaf, properties of, 131
- Wood pulp, Canadian exports of, 47, 238
  - consumption in United States, 43, 226
  - consumption in Canada, 45, 236
  - imports, into the United States, 44, 227
  - in United States, 225
  - industry, 9
    - in United States, rated capacity, 224
    - in Canada, rated capacity, 235
  - produced and exported in Canada, 40, 236
  - production in Canada, 36, 235
    - in United States, 30, 224
  - value of exports from Canada, 47, 238
- Working plans, necessity for, 185
- Working plans, in the Adirondacks, 186, 239
  - in British Columbia, 189, 252
  - in Quebec, 187, 247
  - in the National Forests, 190, 255

Y

- Yucca, properties of, 133

DIRECTOR OF INDUSTRIES. LIBRARY. 21 JUL. 1924 BENGAL.